(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 4 433 220 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
30.04.2025 Bulletin 2025/18

(21) Application number: **24702410.2**

(22) Date of filing: **18.01.2024**

(51) International Patent Classification (IPC):
B05B 7/00 *(2006.01)* ***B65D 83/00*** *(2006.01)*

(52) Cooperative Patent Classification (CPC):
B05B 7/0483; B65D 83/36

(86) International application number:
PCT/GB2024/050133

(87) International publication number:
WO 2024/153935 (25.07.2024 Gazette 2024/30)

(54) **FLUID DISPENSER**

FLÜSSIGKEITSSPENDER

DISTRIBUTEUR DE LIQUIDE

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **20.01.2023 GB 202300898**

(43) Date of publication of application:
25.09.2024 Bulletin 2024/39

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Description

[0001] The present invention relates to a method and apparatus for dispensing fluid. In particular, but not exclusively, the present invention relates to a fluid dispensing device that includes a valve arrangement which selectively controls fluid flow through the device and incudes actuatable valve stem that is operable to dispense liquid fluid mixed with propellant gas, for example compressed gas (for example nitrogen, helium, oxygen, propane, and the like), in a variety of different orientations.

[0002] From time to time there is a requirement to dispense fluid from a container. For example, many healthcare products such as deodorants, hairsprays, suncreams and the like are provided to a consumer as fluids in containers. Examples of other such products that may be provided in such a manner are cooking products, cleaning products, painting products, and the like. In use there is sometimes a need to dispense the fluid contained within these containers to a desired location, for example on the human body.

[0003] Conventional fluid dispensing devices, such as an aerosol can, automatic wall or floor-mounted dispenser unit or the like, often contain a pressurised fluid to be dispensed. Such devices sometimes comprise a stem valve assembly located at an upper portion of a can or other such container for dispensing an amount of fluid product from the can. A stem valve assembly used in such devices may include a stem housing, an elongate stem movable within the stem housing between a valve open and valve closed position, and an actuator for moving the stem. The actuator is sometimes attached to the stem via a simple interference fit. The actuator may include a nozzle for dispensing fluid in a predetermined pattern from the can or other fluid container when the actuator is operated manually or automatically. The actuator sometimes selectively operates the stem valve assembly to allow discharge of the fluid as a spray from the nozzle by means of a propellant provided within the can/container.

[0004] Often these products are provided to consumers in the form or aerosols which contain the desired fluid along with a propellent, that is often a gas, in a can or other such container under pressure. Upon activation of a valve system, a mixture of the fluid and propellant is dispensed from the can as a spray.

[0005] Many conventional fluid dispensing devices need to be arranged substantially upright in order to dispense the desired fluid. Operating such devices in other orientations, for example an inverted orientation, may cause the device to dispense gas propellant only which may drain the aerosol container of propellant. This may result in some fluid in the can being unable to be dispensed due to a lack of propellant. Such fluid in the container is thus wasted.

[0006] Furthermore, some conventional fluid dispensing devices may contain complex valve components. Manufacturing such complex components, for example via moulding or extrusion or the like, can cause imperfections known generally as flash. For example, excess material can remain on inner surfaces of complex valve components which may reduce the efficiency of the valve component or may prevent the valve component from operating in a desired manner.

[0007] AU 2015 270 286 A1, in accordance with its abstract, describes a valve assembly including a housing with an internally projecting lip that seals against an outer surface of a valve stem inserted through it. A gas inlet is provided above the lip and a liquid inlet is provided below the lip. The lip ensures that a gas flow path and a liquid flow path are kept separate until the valve stem is moved to an open position, at which point a liquid inlet hole in the stem is brought into communication with the liquid inlet in the housing and a gas inlet hole in the stem is brought into communication with the gas inlet in the housing for the fluids mix in an outlet conduit in the stem.

[0008] It is an aim of the present invention to at least partly mitigate one or more of the above-mentioned problems.

[0009] It is an aim of certain embodiments of the present invention to provide a valve arrangement for a fluid dispensing device that is able to dispense fluid in a variety of orientations and that suffers reduced risk of manufacturing defects due to a generally symmetrical design.

[0010] It is an aim of certain embodiments of the present invention to provide a valve arrangement for a fluid dispensing device that is operable when the fluid dispensing device is inverted.

[0011] It is an aim of certain embodiments of the present invention to provide a valve arrangement that is generally symmetrical about a primary stem axis on which a valve stem is arranged. According to a first aspect of the present invention there is provided apparatus for dispensing fluid, comprising: at least one inner wall of a housing member that at least partly surrounds an inner chamber region that is disposed within a main body portion of the housing member, an inner fluid port being disposed at a first end region of the inner chamber region and in fluid communication with an open region of the housing member disposed at a first end region of the housing member; at least one fluid communication passageway disposed within the main body portion and comprising a first end of the fluid communication passageway proximate to the open region, and a remaining end of the fluid communication passageway, proximate to a further end of the housing member, that is spaced apart from the first end of the housing member, the fluid communication passageway being disposed radially outside the inner chamber region and being in fluid communication with the open region; at least one wall fluid port extending through the inner wall and through an outer surface of the housing member to fluidly connect a fluid communication region located outside of the housing body and the inner chamber region; a closure element disposed in, and movable within, the inner chamber region to selectively limit fluid flow through the inner fluid port; wherein the housing member is connected to, or is integrally formed with, a valve assembly that includes an elongate valve stem associated with a respective stem axis and a stem housing that radially surrounds at least a portion of the valve stem, the stem housing comprising at least one stem housing fluid communication region that is in fluid communication with the fluid communication passageway and is fluidly connectable to an inner stem channel disposed along at least a portion of the valve stem, the stem housing further comprising at least one gas communication region that is fluidly connectable to the inner stem channel so that at least one fluid and at least one gas are mixable in the stem channel.

[0012] Aptly, the valve stem comprises a fluid inlet port in fluid communication with the stem channel and selectively connectable with the stem housing fluid communication region, and a gas inlet port in fluid communication with the stem channel and selectively connectable with the gas fluid communication region, the fluid inlet port being disposed to be fluidly connected with the stem housing fluid communication region at the same time as the gas fluid port is fluidly with the gas fluid communication region to provide a fine spay in the stem channel by two fluid atomisation.

[0013] Aptly, the apparatus further comprises a valve seat region disposed within the inner chamber region proximate to the first fluid port, the closure element being locatable against the valve seat region for preventing fluid flow through the inner fluid port when the housing member is disposed in a first orientation.

[0014] Aptly, the apparatus further comprises a closure element support region disposed at a further end region of the inner chamber region that is spaced apart from the first end region of the inner chamber region, the closure element being locatable against the closure element support region to permit fluid flow through the inner fluid port when the housing member is disposed in a further orientation.

[0015] Aptly, the housing member is a single body piece that optionally comprises a single moulded body piece.

[0016] Aptly, the closure element has a maximum width that is smaller than a maximum width of a region of the inner chamber region in which the closure element is movable in operation.

[0017] Aptly, the closure element has a maximum width that is smaller than a maximum width of a region of the inner chamber region between the valve seat region and the closure element support region.

[0018] Aptly, the housing member is connected to the valve assembly at a further end region of the housing member that is spaced apart from the first end of the housing member.

[0019] Aptly, the inner chamber region, the inner fluid port and the open mouth are disposed on the stem axis and optionally are substantially symmetrical along the stem axis.

[0020] Aptly, the wall fluid port is oriented along an axis that is substantially perpendicular to the stem axis.

[0021] Aptly, the at least one wall fluid port comprises a pair of wall fluid ports arranged at substantially opposite sides of the housing member.

[0022] Aptly, the apparatus further comprises a first fluid flow path extends from the open region, through the fluid communication passageway, through the stem housing fluid communication region and into the stem channel via a stem fluid port, the stem channel optionally extending along the stem axis.

[0023] Aptly, the first fluid path is operable for fluid flow when the housing member is disposed in the first orientation that optionally comprises the open region facing in a substantially downward direction.

[0024] Aptly, the apparatus further comprises at least one gas pathway that is at least partly disposed between the housing member and a mounting cup through which the valve stem extends so that, in the first orientation, gas can pass through the gas inlet, into the gas communication region, and into a stem gas port via that in the valve stem to mix with fluid in the stem channel.

[0025] Aptly, the apparatus further comprises a further fluid flow path that extends from the fluid communication region to the inner chamber region via the wall fluid port and, via the inner fluid port from the inner chamber region through the fluid communication passageway and into the inner stem channel via a stem fluid inlet.

[0026] Aptly, the further fluid path is operable for fluid flow when the housing member is disposed in the further orientation that optionally comprises the open region facing in a substantially upward direction.

[0027] Aptly, in a first valve stem position the stem fluid port is closed to prevent fluid flow into the stem channel to thereby block the first fluid flow path or the further fluid flow path, and in a further valve stem position the stem fluid port is open to permit fluid flow into the stem channel to thereby permit fluid flow through the first fluid flow path or the further fluid flow path.

[0028] Aptly, the first valve stem position is an equilibrium position, and the further valve stem position is a position in which the valve stem is urged towards the housing member along the stem axis.

[0029] Aptly, the apparatus further comprises at least one biasing element that urges the valve stem towards the first valve stem position.

[0030] Aptly, the apparatus further comprises, a dip-tube comprising a first end region disposed in the open region and a further end region that is spaced apart from the housing body.

[0031] Aptly the apparatus further comprises a sloped wall region of the inner wall that is offset from an axis that touches the radially innermost part of the sloped wall region and is parallel with the stem axis so that the sloped wall region makes an angle of 10 degrees or less with the axis.

[0032] Aptly, the housing member comprises an open mouth region at the terminal end of the open region that is at the first end of the housing member, and a neck region that includes a channel disposed between the open mouth region and the main body portion.

[0033] Aptly, the valve seat region comprises an annular abutment surface for abutting against the closure element that is oblique relative to the stem axis and optionally makes a valve seat angle with the stem axis that is between 30 degrees and 50 degrees.

[0034] Aptly, the valve seat angle is around 45 degrees or 48 degrees.

[0035] According to a second aspect of the present invention, there is provided a fluid dispensing device, comprising: at least one inner wall of a housing member that at least partly surrounds an inner chamber region that is disposed within a main body portion of the housing member, an inner fluid port being disposed at a first end region of the inner chamber region and in fluid communication with an open region of the housing member disposed at a first end region of the housing member; at least one fluid communication passageway disposed within the main body portion and comprising a first end of the fluid communication passageway proximate to the open region, and a remaining end of the fluid communication passageway, proximate to a further end of the housing member, that is spaced apart from the first end of the housing member, the fluid communication passageway being disposed radially outside the inner chamber region and being in fluid communication with the open region; at least one wall fluid port extending through the inner wall and through an outer surface of the housing member to fluidly connect a fluid communication region located outside of the housing body and the inner chamber region; a closure element disposed in, and movable within, the inner chamber region to selectively limit fluid flow through the inner fluid port; and a canister that is connected to a valve assembly via a mounting cup through which the valve stem extends and that comprises at least one fluid to be dispensed and at least one propellant that optionally is a gas; wherein the housing member is connected to, or is integrally formed with, the valve assembly that includes an elongate valve stem associated with a respective stem axis and a stem housing that radially surrounds at least a portion of the valve stem, the stem housing comprising at least one stem housing fluid communication region that is in fluid communication with the fluid communication passageway and is fluidly connectable to an inner stem channel disposed along at least a portion of the valve stem, the stem housing further comprising at least one gas communication region that is fluidly connectable to the inner stem channel so that at least one fluid and at least one gas are mixable in the stem channel.

[0036] According to a third aspect of the present invention there is provided a method for dispensing fluid, comprising the steps of: providing a fluid at a first end of a fluid communication passageway disposed within a main body portion of a housing member and proximate an open region that is located at a first end region of the housing member; and transporting the fluid from the from the first end of the fluid communication passageway to a further end of the fluid communication passageway located at a further end region of the housing member that is spaced apart from the first end region; transporting the fluid from the further end of the fluid communication passageway end to a stem housing fluid communication region that is located in a stem housing that surrounds at least a portion of a valve stem that is associated with a stem axis; providing at least one gas at a gas communication region that is fluidly connectable to an inner stem channel that extends along at least a portion of the valve stem and is connectable to the stem housing fluid communication region; and transporting the fluid from the first end of the fluid communication passageway to the further end of the fluid communication passageway includes transporting the fluid, via the fluid communication passageway, radially outside an inner chamber region that is at least partly surrounded by at least one inner wall of the housing member that is located in the main body portion.

[0037] Aptly, the method further comprises the steps of: fluidly connecting the stem housing fluid communication region to the inner stem channel and simultaneously fluidly connecting the gas communication region to the inner stem channel.

[0038] Aptly, the method further comprises the steps of: mixing the fluid and the gas in the inner stem channel.

[0039] Aptly, the method further comprises the steps of: providing a fine spray in the inner stem channel that is a mixture of the fluid and the gas by two fluid atomisation.

[0040] Aptly, the method further comprises the steps of: in a first mode of operation, prior to providing the fluid at the first end of the fluid communication passageway, urging a closure element disposed within the inner chamber region against a valve seat region that is located proximate to a first end region of the inner chamber region to thereby prevent fluid flow through an inner fluid port that is in fluid communication with the open region and is disposed proximate to the first end region of the inner chamber region; providing the fluid at the open region; and transporting the fluid from the open region to the first end of the fluid communication passageway.

[0041] Aptly, the method further comprises the steps of: orienting the housing member in a substantially upright configuration to locate the open region at a substantially downward position relative to the further end region, and simultaneously moving the closure element against the valve seat region.

[0042] Aptly, the method further comprises the steps of: in a further mode of operation, prior to providing the fluid at the first passage end, urging a closure member disposed within the inner chamber region against a closure member support region that is disposed at a further end region of the inner chamber region that is spaced apart from an inner fluid port disposed proximate to a first end region of the inner chamber region to thereby permit fluid flow through the inner fluid port; via at least one wall fluid port extending through the inner wall and through an outer surface of the housing member, transporting fluid from a fluid communication region that outside of the housing member to the inner chamber region; and transporting fluid from the first fluid communication region to the first passage end via the inner fluid port.

[0043] Aptly, the method further comprises the steps of: orienting the housing member in a substantially inverted configuration to locate the open region at a substantially upward position relative to the further end region, and simultaneously urging the closure element against the closure element support region.

[0044] Aptly, the method further comprises the steps of: transporting, via the stem housing fluid communication region, the fluid from the further passage end at least partly around a valve assembly that is connected to the further end region of the housing member and comprises the valve stem and the stem housing; and transporting the fluid into the inner stem channel via at least one stem fluid port.

[0045] Aptly, the method further comprises the steps of: prior to transporting the fluid into the inner stem channel, urging the valve stem away from an equilibrium position to thereby open the stem fluid inlet of the valve stem optionally by urging the valve stem towards the housing member.

[0046] Certain embodiments of the present invention provide a valve assembly for a fluid dispensing device that can be operated in a number of orientations of the device include an inverted orientation and an upright orientation.

[0047] Certain embodiments of the present invention provide a valve system for a fluid dispensing device that is generally symmetrical about a primary stem axis.

[0048] Certain embodiments of the present invention provide a valve assembly for a fluid dispensing device that suffers reduced risk of manufacturing defects.

[0049] Certain embodiments of the present invention provide a valve assembly for a fluid dispensing device that can continuously dispense fluid while being rotated by 180 degrees.

[0050] Certain embodiments of the present invention provide a valve assembly for a fluid dispensing device that is operable in a variety of different orientations and that can dispense fluid as a fine spray by two fluid atomisation with gas propellant.

[0051] Embodiments of the present invention will now be described hereinafter, by way of example only, with reference to the accompanying drawings in which:

Figure 1 illustrates a partial section of a fluid flow device;

Figure 2 illustrates a valve arrangement of the fluid dispensing device in cross section;

Figure 3a illustrates an upright orientation of the fluid dispensing device;

Figure 3b illustrates the fluid dispensing device rotated away from the upright orientation by 45 degrees;

Figure 3c illustrates the fluid dispensing device rotated away from the upright orientation by 90 degrees;

Figure 3d illustrates the fluid dispensing device rotated away from the upright orientation by 135 degrees;

Figure 3e illustrates the fluid dispensing device rotated away from the upright orientation by 180 degrees and in an inverted orientation;

Figure 3f illustrates the fluid dispensing device in an inverted orientation;

Figure 3g illustrates the fluid dispensing device rotated away from the inverted orientation by 45 degrees;

Figure 3h illustrates the fluid dispensing device rotated away from the inverted orientation by 90 degrees;

Figure 3i illustrates the fluid dispensing device rotated away from the inverted orientation by 135 degrees;

Figure 3j illustrates the fluid dispensing device rotated away from the inverted orientation by 180 degrees and in an upright orientation;

Figure 4 illustrates the direction of fluid spray in the orientations of the fluid dispensing device illustrated in Figures 3a to 3j;

Figure 5a illustrates liquid fluid flow through the valve arrangement when the fluid dispensing device is in the orientation shown in Figures 3a and 3j;

Figure 5b illustrates gas flow through the valve arrangement when the fluid dispensing device is in the orientation shown in Figures 3a and 3j;

Figure 6 illustrates a different perspective cross sectional view of the valve arrangement when the fluid dispensing device is in an upright orientation;

Figure 7a illustrates liquid fluid flow through the valve arrangement when the fluid dispensing device is in the orientation shown in Figures 3b and 3i;

Figure 7b illustrates gas flow through the valve arrangement when the fluid dispensing device is in the orientation shown in Figures 3b and 3i;

Figure 8 illustrates a schematic view of a sealing ball of the valve arrangement abutting against a valve seat region located in an inner chamber region of the valve arrangement;

Figure 9a illustrates liquid fluid flow through the valve arrangement when the fluid dispensing device is in the orientation shown in Figure 3c;

Figure 9b illustrates gas flow through the valve arrangement when the fluid dispensing device is in the orientation shown in Figure 3c;

Figure 10a illustrates liquid fluid flow through the valve arrangement when the fluid dispensing device is in the orientation shown in Figures 3d and 3g;

Figure 10b illustrates gas behaviour in the valve arrangement when the fluid dispensing device is in the orientation shown in Figures 3d and 3g;

Figure 11 illustrates a schematic view of the sealing ball when disposed against a closure element support region located in the inner chamber region;

Figure 12a illustrates liquid fluid flow through the valve arrangement when the fluid dispensing device is in the orientation shown in Figures 3e and 3f;

Figure 12b illustrates gas behaviour in the valve arrangement when the fluid dispensing device is in the orientation shown in Figures 3e and 3f;

Figure 13 illustrates a different perspective cross sectional view of the valve arrangement in an inverted orientation;

Figure 14a illustrates liquid fluid flow through the valve arrangement when the fluid dispensing device is in the orientation shown in Figure 3h;

Figure 14b illustrates gas flow through the valve arrangement when the fluid dispensing device is in the orientation shown in Figure 3h;

Figure 15a illustrates an alternative inner chamber region;

Figure 15b illustrates a schematic view of an alternative valve seat region;

Figure 15c illustrates a schematic view of a further alternative inner chamber region which includes a sloped wall region;

Figure 16 illustrates a top-down perspective view of a spring seat and fluid flow valve housing of the valve arrangement;

Figure 17 illustrates a side-on perspective cross sectional view of the fluid flow valve housing;

Figure 18 illustrates a different side-on perspective cross sectional view of the fluid flow valve housing;

Figure 19 illustrates a different perspective cross sectional view of the fluid flow valve housing;

Figure 20 illustrates a different perspective cross sectional view of the fluid flow valve housing;

Figure 21 illustrates a different perspective cross sectional view of the fluid flow valve housing;

Figure 22 illustrates a perspective bottom-up view of the fluid flow valve housing;

Figure 23 illustrates a different perspective substantially bottom-up view of the fluid flow valve housing;

Figure 24 illustrates a schematic top-down view of how fluid communication pathways and wall fluid ports are arranged in the fluid flow valve housing;

Figure 25a illustrates a cross sectional view of the valve arrangement in a closed position and in an upright orientation;

Figure 25b illustrates a cross sectional view of the valve arrangement in an open position and in an upright orientation;

Figure 25c illustrates a cross sectional view of the valve arrangement in an open position and in an inverted orientation;

Figure 26a illustrates a side-on perspective view of the valve arrangement;

Figure 26b illustrates a top-down perspective view of the valve arrangement;

Figure 26c illustrates a bottom-up perspective view of the valve arrangement;

Figure 27a illustrates a top-down perspective view of the spring seat;

Figure 27b illustrates a side-on perspective view of the spring seat;

Figure 27c illustrates a bottom-up perspective view of the spring seat;

Figure 27d illustrates the spring seat in cross section;

Figure 27e illustrates a different perspective view of the spring seat;

Figure 28a illustrates a top-down perspective view of a stem valve assembly housing of the valve arrangement;

Figure 28b illustrates a side-on perspective view of the stem valve assembly housing;

Figure 28c illustrates a bottom-up perspective view of the stem valve assembly housing;

Figure 28d illustrates the stem valve assembly housing in cross section;

Figure 28e illustrates a portion of the stem valve assembly housing in more detail;

Figure 28f illustrates a further portion of the stem valve assembly housing in more detail;

Figure 28g illustrates a different perspective view of a stem valve assembly housing;

Figure 29a illustrates a cross sectional view of the valve assembly in an upright orientation;

Figure 29b illustrates a further cross sectional view of the valve arrangement in an upright orientation;

Figure 29c illustrates a still further cross sectional view of the valve arrangement in an upright orientation;

Figure 29d illustrates a cross sectional view of the valve arrangement in an inverted orientation;

Figure 30a illustrates a side-on perspective view of the valve arrangement;

Figure 30b illustrates a bottom-up perspective view of the valve arrangement;

Figure 30c illustrates a top-down perspective view of the valve arrangement;

Figure 30d illustrates a different perspective view of the valve arrangement;

Figure 31a illustrates a perspective view of how the valve arrangement can be assembled; and

Figure 31b illustrates the assembled valve arrangement in cross section.

[0052] In the drawings like reference numerals refer to like parts.

[0053] Figure 1 illustrates a fluid dispensing device 100 in an "open" mode of operation. The fluid dispensing device may, for example, be an aerosol spray device such as an aerosol can which provides fluid to be dispensed as a mist of particles. It will be appreciated that the can is an example of a container. Only a partial section of such a can is illustrated in Figure 1. It will be appreciated that other fluid dispensing devices which do not emit fluid as an aerosol may also be provided, for example devices emitting creams, gels, foams or the like. The fluid dispensing device 100 comprises a rigid container 105 onto which is mounted a stem valve assembly 110. The stem valve assembly 110 is held in a central position at the top of the container 105 by way of a mounting cup 115. The mounting cup 115 is selectively crimped around the edges of the rigid container 105 and around a region of the stem valve assembly 110 to thereby hermetically seal the container. The fluid dispensing device 100 of Figure 1 also includes an outer sealing gasket 118 and inner sealing gasket 120 provided in the regions proximate the crimped regions of the mounting cup 115 to support the sealing provided by the crimping process. Alternatively, the fluid dispensing device may not include an outer and/or inner sealing gasket. Alternatively, the fluid dispensing device may include additional sealing gaskets. The inner and outer sealing gaskets of Figure 1 are made from a polymeric material. Alternatively, any other suitable material may be used to make the inner and outer sealing gaskets. It will be appreciated that alternative methods for providing a sealing engagement may be used in place of crimping, for example interference fits, liquid sealants and the like. It will be appreciated that the container 105 may be made from a metallic material. Aptly the container 105 may be made from an alloy material, for example aluminium. The container 105 may be made from any other suitable material. It will be appreciated that the mounting cup 115 may be made from a metallic material. Aptly the mounting cup 115 may be made from an alloy material, for example aluminium. The mounting cup 115 may be made from any other suitable material.

[0054] A fluid reservoir 125 is provided within the sealed container and generally comprises a quantity of liquid (product) to be dispensed. It will be understood that the liquid in the fluid reservoir is an example of a fluid to be dispensed. Any liquid component is free to move in the container and will adopt a surface level due to gravitational effects. It will be appreciated that the surface level adopted by the liquid component in the container 105 will be dependent on the orientation of the fluid dispensing device 100 and any given time. The fluid reservoir 125 may be dispensed from the device (when in the "open" mode of operation as is shown in Figure 1) by using a propellant contained within a head space 130 of the sealed container which "forces" the product to exit the container. The propellant may be a compressed gas such as carbon dioxide, nitrogen, air or the like. Mixtures of two or more gases may also be used as the propellant. It will be understood that according to certain embodiments of the present invention, the propellant may have some solubility with the fluid reservoir 125 and therefore upon dispersal of liquid product from the fluid reservoir, some propellant held as a liquid may also be dispersed. The gas in the head space may, for example, be at an initial pressure of 5 to 20 bar depending on the type of container in use. The initial pressure may, for example, be 9 to 12 bar. The initial pressure may, for example, be around 8 bar. Higher pressure cans, for example, cans with an initial pressure of 18 bar or higher, could of course instead be utilised.

[0055] The stem valve assembly 110 comprises an elongate valve stem 135 which can be moved in a reciprocating fashion along a primary stem axis 140 (represented by the broken line in Figure 1) upon pressing and releasing of an actuator 145 mounted to the valve stem. It will be understood that the elongate valve stem 135 sits in a first, closed position when no force is provided on the actuator and is held in this position by a resilient member 148 that is a spring in the system shown in Figure 1. Alternatively, any other suitable resilient member could instead be utilised. It will be understood that the spring 148 is an example of a biasing element. Any other suitable biasing element could alternatively be utilised. When the elongate valve stem 135 is in a closed position, corresponding to a closed mode of operation of the fluid dispensing device 105, fluid is not able to communicate from a stem valve assembly fluid communication region 149 that is located in a stem valve assembly housing 150, to a dispense nozzle 155 of the actuator 145. It will be appreciated that the stem valve assembly housing is an example of a stem housing. In use, the actuator 145 may be pressed downwards (towards the stem valve assembly housing 150) as represented by the arrow A in Figure 1, and therefore selectively urged along the primary stem axis 140 to thereby overcome the force on the valve stem provided by the spring 148, and thereby urge the elongate valve stem 135 into the open position shown in Figure 1. When the elongate valve stem 135 is in the open position, fluid is able to communicate between the stem valve assembly fluid communication region 149 and the dispense nozzle 150, thereby producing an external aerosol spray 152 which may be provided to a target. It will be appreciated that, in the closed position, the valve stem is pushed in an upwards direction (relative to the position shown in Figure 1) away from the stem valve assembly housing 150 so that a greater proportion of the valve stem protrudes out of the can through the mounting cup 115.

[0056] As indicated above, the stem valve assembly 110 includes a stem valve assembly housing 150 which at least partly houses the elongate valve stem 135 and spring 148. In the closed position of the valve stem 135, wherein the spring 148 urges the valve stem upwards (in the viewpoint provided by Figure 1), a projecting shoulder 165 of the valve stem 135 abuts against an inwardly projecting lip 170 of the stem valve assembly housing 150 of the stem valve assembly 110 to thereby sealingly engage the valve stem. That is to say, in the "closed" position of the fluid dispensing device, the projecting shoulder 165 of the valve stem 135 abuts against the inwardly projecting lip 170 of the stem valve assembly housing 170 so that an effective seal is provided between the projecting shoulder 165 and the lip 170. It will be understood that the inner sealing gasket 120, when used, also contributes to sealingly engaging the valve stem 135. It will be appreciated that certain embodiments of the present invention are usable with other conventional valve assemblies/actuators.

[0057] It will be appreciated that the valve stem 135 may be manufactured from a metallic material, for example an alloy material that may be aluminium. It will be appreciated that the stem 135 may be manufactured from a polymeric material, for example a plastic material. It will be appreciated that the stem valve assembly housing 150 may be manufactured from a polymeric material, for example a plastic material. It will be understood that the stem valve assembly housing 150 may be manufactured by moulding or the like. It will be understood that the stem valve assembly housing may be manufactured by extrusion or the like.

[0058] Upon pressing the actuator 145 and bringing the valve stem into the open position, as shown in Figure 1, the projecting shoulder 165 disengages from the inwardly projecting lip 170 and a stem fluid inlet port 175 of the valve stem moves to a location within the stem valve assembly housing 155 beneath the inwardly projecting lip 170. This enables fluid communication between the stem valve assembly fluid communication region 149 and the stem fluid inlet 175 so that fluid located in the stem valve assembly fluid communication region 149 can pass into the stem fluid inlet. This thus allows fluid located in the stem valve assembly fluid communication region to travel into an inner stem channel 176 that extends at least partly through the stem along the primary stem axis and between the stem fluid inlet 175 and is in fluid communication with the stem fluid inlet 175. As shown in Figure 1, the stem fluid inlet 175 (that is a stem fluid inlet port 175) is disposed on a side of the valve stem 135. As will be discussed in more detail below, a gas flow passageway 178 is provided in the stem valve assembly housing 150 to facilitate fluid communication with a stem gas inlet 179 in the valve stem when the valve stem is in the open position. This facilitates entry of gas into the stem channel 176 via the stem gas port 179 when the stem is in the open position. Thus, when the stem is in the open position, liquid to be dispensed and propellant gas can mix in the stem channel. This will be discussed in more detail below. As shown in Figure 1, the stem gas inlet 179 is disposed on a side region of the valve stem 135 that is substantially opposite to the stem fluid inlet 175. Alternatively the stem gas inlet 179 may be located at any other suitable position on the valve stem 135.

[0059] The fluid dispensing device of Figure 1 also includes a fluid flow valve assembly 190 that is arranged below (from the viewpoint provided in Figure 1) the stem valve assembly. As will be discussed below, the fluid flow valve assembly 190 permits fluid dispensing from the fluid dispensing device 100 in a variety of orientations of the fluid dispensing device 100. As shown in Figure 1, a dip-tube 195 is connected to an end of the fluid flow valve assembly 190 that faces downwards in the viewpoint provided in Figure 1.

[0060] It will be understood that the fluid flow valve assembly 190 is locatable in fluid communication with the fluid reservoir 125 when the can is upright (as shown in Figure 1) due to the connected between the dip-tube 195 and the fluid flow valve assembly 190. It will be understood that when the fluid dispensing device 100 is tipped with respect to the primary stem axis 140, the dip tube 195 may no longer be in fluid communication with the fluid reservoir 125. As will be discussed below, when tipped the fluid flow valve assembly 190 provides an alternative fluid pathway in which fluid may still be communicated to the dispense nozzle 150.

[0061] It will be appreciated that the stem valve assembly 150, the fluid flow valve assembly 190, the dip tube 195, and the mounting cup 115 together form a valve arrangement 199 of the fluid dispensing device 100.

[0062] Figure 2 illustrates a cross sectional view of the valve arrangement 199 of the fluid dispensing device 100 of Figure 1 in more detail. As discussed with respect to Figure 1, the valve arrangement includes a stem valve assembly 110. The stem valve assembly 110 includes a valve stem 135, a portion of which is arranged in the stem valve assembly housing 150. The stem 135 includes a stem channel 176, that is an internal channel, that extends along at least a part of the valve stem 135, at least from the stem fluid inlet 175 to a terminal end of the stem 205. As shown in Figure 2, the inner stem channel 176 extends from a position slightly past the stem fluid inlet 175 to a terminal end 205 of the stem 135. From the perspective shown in Figure 2, the terminal end 205 of the stem 135 is the upward most end of the stem. That is to say that the terminal end 205 of the stem 135 is the end of the stem most distal to, and facing away from, the stem valve assembly housing 150. As shown in Figure 2, the inner stem channel extends only partly through the valve stem and is arranged along the primary stem axis 140 (shown in Figure 1). Alternatively, the inners stem channel 176 may extend wholly through the stem 135.

[0063] As indicated in Figure 2 a portion of the stem that is located in the stem valve assembly housing 150 includes a flared-out stem region 210 beneath which an end of the spring 148 is arranged. It will be appreciated that the flared-out stem region 210 includes the projecting shoulder 165 of the stem 135. The flared-out stem region 210 includes a spring abutment surface 206 that abuts against an end of the spring 148 and against which the spring 148 can impart a biasing force to urge the stem 135 towards the "closed" position which corresponds with the position of the stem 135 when the fluid dispensing device is in a "closed" mode of operation. As shown in Figure 2, the remaining end of the spring 148 sits in a spring seat 215 that is located proximate to a lowermost region the stem valve assembly housing 150 from the viewpoint shown in Figure 2. The spring seat 215 of Figure 2 is a separate component to the stem valve assembly housing 150. That is to say that the spring seat 215 is not integrally formed with the stem valve assembly housing 150. Aptly the spring seat 215 may be integrally formed with the stem valve assembly housing 150.

[0064] As noted with respect to Figure 1, the stem valve assembly housing 150 of Figure 2 includes a gas flow passageway 178 to permit gas flow into the stem valve assembly housing 150 and the stem has a stem gas inlet 179 when the stem 135 is in an open position which corresponds to a position of the stem 135 when the fluid dispensing device is disposed in an "open" mode of operation. Thus the gas flow passageway 178 (along with the stem gas inlet 179) permits gas within the stem valve assembly to enter into the inner stem channel 176 when the stem 135 is disposed in an open position (or open mode of operation). Gas flow through the stem valve assembly 110 will be discussed in more detail below.

[0065] As is shown in Figure 2, and as already discussed with respect to Figure 1, the valve arrangement also includes an inner sealing gasket 120 that is arranged around the stem 135 at the top (from the perspective shown in Figure 2) of the stem valve assembly housing 135, within the housing.

[0066] As was discussed with respect to Figure 1, a mounting cup 115 is crimped around the stem valve assembly housing 150. An outer sealing gasket 118 is arranged on an inner surface of at the outer circumference of the mounting cup 115 where the mounting cup 115 is connected to the can to thereby seal the interface between the mounting cup 115 and the can.

[0067] As discussed with respect to Figure 1, a fluid flow valve assembly 190 is also included in the valve arrangement 199. As shown in Figure 2, the fluid flow valve assembly 190 includes a fluid flow valve housing 220 that is an example of a housing member. The fluid flow valve housing 220 is located underneath, from the perspective shown in Figure 2, and is connected to the stem valve assembly housing 150. An open mouth region 225 of the of the fluid flow valve housing 220 is secured around a retaining portion 230 of the stem valve assembly housing 150 that is located at a lower end (from the view shown in Figure 2). The retaining portion 230 of the stem valve assembly housing 150 includes three circumferential ridges 232 that extend radially outwardly from the stem valve assembly housing 150 outer surface at the retaining portion 230. One, two, or any other suitable number of ridges may of course alternatively be included. The ridges 232 each cooperate with a corresponding groove 233 in the inner surface of the open mouth region 225 of the fluid flow valve housing 220 and thus the stem valve assembly housing 150 and the fluid flow valve housing 220 are secured by a combination of an interference fit and the cooperation between the cooperating grooves 233 and ridges 232. In the valve arrangement 199 shown in Figure 2, the stem valve assembly housing 150 and the fluid flow valve assembly 220 housing are two distinct units. That is to say that the stem valve assembly housing 150 and the fluid flow valve assembly housing 220 are manufactured separately and are subsequently connected as described above. The stem valve assembly housing 150 and the fluid flow valve assembly housing 220 could of course be a single unit that is integrally formed. It will be appreciated that that other appropriate securing methods, such as use of screw threads alongside corresponding screws and the like, may be used to secure the stem valve assembly housing 150 to the fluid flow valve housing 220.

[0068] At a remaining end of the fluid flow valve assembly housing 220 is an open region 235. As shown in Figure 2, this end of the fluid flow valve assembly housing 220 is substantially opposite to the end of the fluid flow valve assembly housing 220 that includes the open mouth region 225. That is to say that the end of the fluid flow valve assembly housing 220 that includes the open region 235 is spaced apart from and is substantially parallel with the end of the fluid flow valve assembly housing 220 that includes the open mouth region 225. It will be appreciated that the end of the fluid flow valve assembly housing 220 that includes the open region 235 is an example of a first end of the fluid flow valve assembly housing and is thus an example of a first end of a housing member. It will also be understood that the end of the fluid flow valve assembly housing 220 that includes the open mouth region 225 is an example of a further end of the fluid flow valve assembly housing and thus is also an example of a further end of a housing member. As is shown Figure 2, the open region 235 includes an elongate neck region that includes an open-ended channel 243, that is to say the open-ended channel 243 is a channel that is open at the first end of the fluid flow valve housing 220. An end region of the dip-tube 195 is arranged in the open-ended channel 243 so that the dip-tube 195 is secured to the fluid flow valve assembly housing 220 via an interference fit.

[0069] It will be appreciated that by having separate parts enables (for example separate stem valve assembly housing 150, dip-tube 195, fluid flow valve housing 220 and mounting cup 215) such components to be retrofitted to certain fluid dispensing devices.

[0070] Figure 2 also shown how the open region 235 of the fluid flow valve assembly housing 220 extends from a main body portion 240 of the fluid flow valve assembly housing. The main body potion 240 of the fluid flow valve assembly housing 220 is a widened region of the fluid flow assembly housing 220 relative to the open region 235. The main body portion 240 includes an inner chamber region 245. The inner chamber region 245 is partially surrounded by a generally cylindrical inner wall 250 of the fluid flow valve assembly housing 220. The inner chamber region 245 is thus generally cylindrical. It will be understood that the inner chamber region 245 may be of any other suitable shape and therefore any suitable number of inner walls may at least partly surround the inner chamber region 245. As shown in Figure 2, at a lowermost end of the inner chamber region 245 (from the viewpoint provided by Figure 2), that is an example of a first end region 246 of the inner chamber region 245, that is most proximate to the open region 235 of the fluid flow valve housing 220, an inner fluid port 255 is located. The inner fluid port 255 is in fluid communication with the open region 235 of the fluid flow valve housing 220. A sealing ball 260, that is an example of a closure element, is located in the inner chamber region 245. It will be appreciated that the sealing ball 260 is movable in the inner chamber region 245. The sealing ball may be manufactured from polymeric material or metallic material or composite material or the like. For example, the sealing ball 260 may be plastic or rubber or the like. It will be appreciated that any other suitable closure element may instead be utilised, for example a plate shaped closure element or a cylindrical closure element or a cube shaped closure element or the like.

[0071] As shown in Figure 2, the inner chamber region 245 is both longer and wider than a diameter of the sealing ball 260 and thus the sealing ball 260 is movable both laterally and longitudinally in the inner chamber region 245. That is to say that the sealing ball 260 is movable in three dimensions in the inner chamber region 245 including in an up and down motion (from the perspective view shown in Figure 2) and in a side to side motion (from the perspective view shown in Figure 2). As shown in Figure 2, the sealing ball 260 is able to sit against a valve seat 265 or collar (that is an example of a valve seat region) to fluidly disconnect the inner fluid port and the inner chamber region 245. It will be appreciated that the sealing ball 260 is freely movable towards and away from the valve seat 265 in the inner chamber region 245. It will be understood that the valve seat 265 is located proximate to the first end region 246 of the inner chamber region 245 and proximate to the inner fluid port 255.

[0072] As illustrated in Figure 2, the top of the inner chamber region 245 (from the perspective view shown in Figure 2), that is an example of a further end region 257 of the inner chamber region 245, is provided by the spring seat 215. It will be understood that the spring seat 215 is a separate unit with respect to the fluid flow valve housing 220 (that includes the inner wall 250) and sits on top of the cylindrical inner wall 250. It will be appreciated that the further end region 257 of the inner chamber region 245 is a remaining end of the inner chamber region 245 that is spaced apart from the first end region 246 of the inner chamber region 245.

[0073] The inner wall 250 if the fluid flow valve housing 220 includes two wall fluid ports 270 that are side ports disposed in the cylindrical inner wall 250. Only one of these ports 270 is illustrated in Figure 2 and extends into the page in the perspective view shown in Figure 2. It will be appreciated that the remaining port 270 extends out of the page, in the perspective view shown in Figure 2, but is not illustrated in the cross sectional view of Figure 2. Alternatively, one, three, four or any other suitable number of wall fluid ports 270 can be utilised. The wall fluid ports fluidly connect the inner chamber region 245 (that includes an inner chamber fluid communication region 275) with a fluid communication region 280 that is arranged external to the fluid flow valve housing 220 and within the can. The wall fluid ports 270 each extends through the inner surface 250 of the fluid flow valve housing 220 and through an outer surface 271 of the fluid flow valve housing.

[0074] As can also be seen in Figure 2, the main body portion 240 of the fluid flow valve inner housing includes two fluid communication passageways 290 on opposed sides of the inner chamber region 245 that extend around the inner chamber region 245 and are in fluid communication with the open region 235 of the fluid flow valve housing 220. That is to say that the fluid communication passageways 290 are arranged radially outside of the inner chamber region 245 and are spaced apart from the inner chamber region 245 within then fluid flow valve housing 220. It will be understood that the fluid communication passageways 290 each include a first end 291 that is located proximate to the open region 235 of the fluid flow valve housing 220 and a further end 292 that is located proximate to the open mouth region 225 of the fluid flow valve housing 220. The fluid communication passageways 290 thus extend from the open region 235 to the open mouth region 225 through the fluid flow valve housing 220 and thus fluidly connect the open region 235 and open mouth region 225.

[0075] The fluid flow valve housing 220 of Figure 2 is a single unit. That is to say the fluid flow valve housing 220 is formed as a single body, optionally via a moulding process.

[0076] It will be understood that the fluid flow valve housing 220 and the stem valve assembly housing 150 are substantially symmetrical around the stem axis (with the exception of certain ports such as the gas flow passageway, the fluid wall fluid ports and the fluid communication pathways) However a planar slice through the stem valve assembly housing and the fluid flow valve assembly housing across the page of the viewpoint shown in Figure 2 yields two symmetrical portions of the stem valve assembly housing and the fluid flow valve assembly housing. That is to say that the stem valve assembly housing and the fluid flow valve assembly housing each are a single unit, formed as single bodies, that each include substantially symmetrical half portions.

[0077] Figure 3a to Figure 3j illustrate a variety of orientations of the fluid dispensing device 100 of Figure 1, in cross section, that may be utilised in operation of the fluid dispensing device 100. Figures 3a to 3e illustrate how the fluid dispensing device 100 can be tilted, in an anticlockwise direction, from an upright orientation to an invented orientation in use while maintaining a substantially constant spray of fluid. Figures 3f to 3j illustrate how the fluid dispensing device 100 can be tilted, in an anticlockwise direction, from an invented orientation to an upright orientation while maintaining a substantially constant spray of fluid.

[0078] Figure 3a illustrates the fluid dispensing device 100 of Figure 1 in an upwards or upright orientation 305. It will be appreciated that the upright orientation is the same orientation as illustrated in Figure 1. Figure 3a helps illustrate how the fluid reservoir 125 settles and adopts a surface level that is substantially perpendicular to the primary stem axis 140 (shown in Figure 1) when the fluid dispensing device is in an upright orientation. Figure 3a also helps illustrate how the stem 135 extends along an stem axis that is parallel with (and extends along) the primary stem axis 140 shown in Figure 1 when the fluid dispensing device is disposed in an upright orientation. Figure 3a also helps illustrate how the dip-tube 195 is arranged such that an end of the dip-tube 195 not connected to the fluid flow valve housing 220 is disposed in the fluid reservoir when the fluid dispensing device 100 is arranged in an upright orientation.

[0079] Figure 3b illustrates the fluid dispensing device 100 of Figure 1 tilted in diagonal, but still substantially upright, orientation 310 away from the upright position 305 of Figure 3a in an anticlockwise direction. It will be understood that the orientation 310 shown in Figure 3b is a 45 degree rotation of the fluid dispensing device 100 away from the upright orientation 305 of Figure 1 in an anticlockwise direction. It will thus be understood that the stem 135 extends along an axis, that is a stem axis, that is at 45 degrees with respect to the primary stem axis 140 shown in Figure 1 when the fluid dispensing device is in the orientation 310 of Figure 3b. As shown in Figure 3b, the fluid reservoir 125 settles so that a surface level of the reservoir is oblique to the axis along which the stem 135 extends. It will be understood that the surface of the fluid reservoirs settles via gravity and thus will always be substantially perpendicular to the primary stem axis 140 shown in Figure 1. As shown in Figure 3b, the dip-tube 195 is arranged such that an end of the dip-tube 195 not connected to the fluid flow valve housing 220 is disposed in the fluid reservoir 125 in the orientation of Figure 3b.

[0080] Figure 3c illustrates the fluid dispensing device 100 tilted from an upright orientation 305 in an anticlockwise direction to be in a substantially lateral orientation 315. It will be understood that the orientation 315 shown in Figure 3c is a 90 degree rotation of the fluid dispensing device 100 away from the upright orientation 305 of Figure 1 in an anticlockwise direction. It will thus be understood that the stem 135 extends along an axis, that is a stem axis, that is at 90 degrees with respect to the primary stem axis 140 shown in Figure 1 when the fluid dispensing device 100 is in the orientation 310 of Figure 3c. As shown in Figure 3c, the fluid reservoir 125 settles so that a surface level of the reservoir is substantially parallel the axis along which the stem 135 extends. As shown in Figure 3c, the dip-tube 195 is arranged such that an end of the dip-tube 195 not connected to the fluid flow valve housing 220 is disposed in the fluid reservoir 125 in the orientation of Figure 3c.

[0081] Figure 3d illustrates the fluid dispensing device tilted in a diagonal, but substantially inverted, orientation 325 away from an upright 305 orientation in an anticlockwise direction. It will be understood that the orientation 325 shown in Figure 3d is a 135 degree rotation of the fluid dispensing device 100 away from the upright orientation 305 of Figure 1 in an anticlockwise direction. It will thus be understood that the stem 135 extends along an axis, that is a stem axis, that is at 135 degrees with respect to the primary stem axis 140 shown in Figure 1 when the fluid dispensing device 100 is in the orientation 310 of Figure 3d. As shown in Figure 3d, the fluid reservoir 125 settles so that a surface level of the reservoir is oblique to the axis along which the stem 135 extends. As shown in Figure 3d, the dip-tube 195 is arranged such that an end of the dip-tube 195 not connected to the fluid flow valve housing 220 is disposed outside of fluid reservoir 125 in the orientation of Figure 3d.

[0082] Figure 3e illustrates the fluid dispensing device 100 in an inverted orientation 325. It will be appreciated that the inverted orientation 325 is an orientation that is rotated by 180 degrees from the upright orientation shown in Figure 3a. It will thus be understood that the stem 135 extends along an axis, that is a stem axis, that is at 180 degrees with respect to the primary stem axis 140 shown in Figure 1 when the fluid dispensing device 100 is in the orientation 310 of Figure 3d. That is to say that the stem extends along the primary stem axis 140 shown in Figure 1 but points in the opposite direction (downwards) compared with the upright orientation 305 (shown in Figures 1 and 3a). As shown in Figure 3d, the fluid reservoir 125 settles so that a surface level of the reservoir is substantially perpendicular to the axis along which the stem 135 extends. As shown in Figure 3s, the dip-tube 195 is arranged such that an end of the dip-tube 195 not connected to the fluid flow valve housing 220 is disposed outside of the fluid reservoir 125 in the orientation of Figure 3d.

[0083] Figure 3f to 3j illustrate the orientation of the fluid dispensing device 100 when the fluid dispensing device 100 is tilted from the inverted position 325 shown in Figure 3e to the upright position illustrated in Figure 3a 305.

[0084] Figure 3f illustrates the fluid dispensing device in an inverted orientation 330. It will be appreciated that the inverted orientation 330 is an orientation that is rotated by 180 degrees from the upright orientation shown in Figure 3a 305. It will be appreciated that the orientation 330 shown in Figure 3f is substantially the same as the invented orientation 325 discussed with respect to Figure 3e.

[0085] Figure 3g illustrates the fluid dispensing device 100 in a tilted, but substantially downward facing, orientation 340 that is a 45 degree rotation from the inverted orientation 330 shown in Figure 3f. It will be appreciated that the orientation 340 shown in Figure 3g is substantially the same orientation 320 discussed with respect to Figure 3d.

[0086] Figure 3h illustrates the fluid dispensing device in a substantially sideways or lateral orientation 350 that is a 90 degree rotation from the inverted orientation 330 shown in Figure 3f. It will be appreciated that the orientation 350 shown in Figure 3f is substantially the same as the orientation 315 discussed with respect to Figure 3h. It is noted however that the sealing ball 260 is disposed in a different position in the inner chamber region 245 relative to the orientation 315 shown in Figure 3c.

[0087] Figure 3i illustrates the fluid dispensing device in a tilted, but substantially upward facing, orientation 360, that is a

135 degree rotation from the inverted orientation 330 shown in Figure 3f. It will be appreciated that the orientation 360 shown in Figure 3i is substantially the same as the orientation 315 discussed with respect to Figure 3b.

[0088] Figure 3f illustrates the fluid dispensing device in an upright orientation 370 that is a 180 degree rotation from the inverted orientation 330 shown in Figure 3f, and is the substantially same orientation as is discussed with respect to Figure 3a.

[0089] Figure 4 illustrates the direction of fluid spray 152 from the fluid dispensing device 100 of Figure 1 when the fluid dispensing device 100 disposed in the orientations shown in Figures 3a to 3j. Direction 1 410 corresponds to the orientations 305, 370 discussed with respect to Figures 3a and 3j. Direction 2 420 corresponds to the orientations 310, 360 discussed with respect to Figures 3b and 3i. Direction 3 430 corresponds to the orientations 315, 350 discussed with respect to Figures 3c and 3h. Direction 4 440 corresponds to the orientations 320, 340 discussed with respect to Figures 3d and 3g. Direction 4 450 corresponds to the orientations 325, 330 discussed with respect to Figures 3e and 3f.

[0090] Figure 5a illustrates the valve arrangement 199 of Figure 2 in cross section when the fluid dispensing device 100 is oriented in the substantially upright orientation 305, 370 of Figures 3a and Figure 3j. In particular, Figure 5a illustrates how liquid, that is a fluid to be dispensed initially disposed in the fluid reservoir, can flow through the valve arrangement when the fluid dispensing device is arranged in a substantially upright orientation 305, 370. The arrows in Figure 5a illustrate liquid flow through the valve arrangement 199. It will be understood that the upright orientation 305, 370 of the fluid dispensing device 100 (and thus of the valve arrangement 199) is an example of a first mode of operation of the fluid dispensing device 100 and valve arrangement 199. It will be understood that when the fluid dispensing device 100 is arranged in an upright orientation 305, 370, the remaining end of the dip-tube 195 that is not secured in the open region 235 of the fluid flow valve housing 220 is arranged proximate to the bottom of the can of the fluid dispensing device 100 and is thus arranged in the fluid reservoir 125 (should there be sufficient fluid remaining in the can for fluid dispensing). It will be understood that the gas propellent arranged in the headspace 130 above the fluid reservoir 125 is pressurised and thus pushes downwards on the fluid reservoir 125. This pressure acting on the fluid reservoir 125 acts to urge the liquid up through the dip-tube 195 and into the open region 135 of the fluid flow valve housing 220 (through the dip-tube 195 that is arranged in the open region 135).

[0091] As illustrated in Figure 5a, the sealing ball 260 is arranged on the valve seat 265 when the fluid dispensing device 100 is arranged in a substantially upright orientation 305, 370. It will be appreciated that the sealing ball 260 is arranged on the valve seat 265 by gravity. The sealing ball 260 thus prevents liquid at the open region 235 of the fluid flow valve assembly 220 from entering the inner chamber region 245 via the inner fluid port 255. That is to say that the inner chamber region 245 and the open region 235 are fluidly disconnected by the sealing ball 260. Liquid is instead forced around, into, and through the two fluid communication passageways 290 and thus the fluid travels around the inner chamber region 245. Liquid thus travels from the open region 235 of the fluid flow valve housing 220 to the open mouth region 225 via the fluid communication passageways 290. The liquid is thus forced from the open mouth region 225 up into a stem valve assembly fluid communication region 149 (that is a stem housing fluid communication region) of the stem valve assembly housing 150. As shown in Figure 5a, the stem valve assembly fluid communication region 148 extends around the valve stem 135.

[0092] It will be understood that when the stem 135 is in a closed position, the stem shoulder 165 is urged into abutment with the inner lip 170 of the stem valve assembly housing 150 by the spring 148. The stem shoulder 165 and inner lip 170 thus form a seal and prevent liquid from flowing into the stem fluid inlet 175 of the stem 135. However, when the stem 135 is depressed and moved (or urged against the biasing force provided by the spring 148) into an open position as shown in Figure 5a, the stem shoulder 165 is axially separated from the inner lip 170 and the stem fluid inlet 175 is arranged below the inner lip 170 (from the viewpoint illustrated in Figure 5a). As is illustrated in Figure 5a, liquid is urged from the stem valve assembly fluid communication region 225 through the stem fluid inlet 175 and into the stem channel 176 to be sprayed out of the fluid dispensing device 100 when mixed with propellant.

[0093] Figure 5b illustrates gas flow through the valve arrangement 199 on Figure 5a when the fluid dispensing device 100 is in the upright configuration 305, 370 of Figure 3a and 3j. Figure 5b illustrates the valve arrangement 199 in cross section. As shown in Figure 5b, gas propellant in the can headspace 130 above the fluid reservoir 125 passes through a gas inlet region 510 between an inner surface of mounting cup 115 and the outer surface of the fluid flow valve housing 220 at the open mouth region 225 of said housing. The gas passes, via the gas inlet region 510 into a gas communication region 520 located between the inner surface of the mounting cup 115 and an outer surface of the stem valve assembly housing 150. The gas can then pass from the gas communication region 520 into the gas flow passageway 178 of the stem valve assembly housing 150, from the gas flow passageway 178 to a gas flow region 530 beneath the inner sealing gasket 120 and radially around the stem 135. When the stem 135 is in the closed position, the stem gas inlet 179 of the stem 135 is located at or above the inner sealing gasket 120 and thus the inner sealing gasket 120 prevents gas flow from the gas flow region 530 beneath the inner sealing gasket 120 into the stem gas inlet 179. When the stem 135 is depressed and in an open position, as illustrated in Figure 5a, the stem gas inlet 179 is moved to be located beneath the inner sealing gasket 120 and thus gas propellant can flow into the stem channel 176 via the stem gas inlet 179.

[0094] It will be understood that liquid fluid and gas propellent enter the stem channel 176 simultaneously when the stem 135 is depressed, or urged towards the stem valve assembly housing 150, to be in an open position. Two fluid atomisation thus occurs in the stem channel 176 when the liquid fluid and the gas propellant mix. That is to say, mixture between the high-pressure gas propellant and the liquid fluid to be dispensed results in the fluid being separated into fine droplets that is essentially is in a gas phase (or at least is substantially similar to being in a gas phase) which are propelled upwards though the stem channel 176 and out of the fluid dispensing device 100 via the nozzle 155 as a fine spray. The stem channel 176 is thus an example of a two fluid atomisation region. It will be appreciated that when the stem 135 is depressed into the open position, the stem fluid inlet 175 allows fluid to flow into the stem channel 176 at the same time as the stem gas inlet 179 allows gas to flow into the stem channel 176 to allow two fluid atomisation to occur.

[0095] It will be understood that, when the fluid dispensing device 100 is in an upright orientation 305, 370, the wall fluid ports 270 located in the inner wall 250 of the fluid flow valve housing 220 are located within the headspace region 130 of the can and thus pressurised propellant gas can pass from the headspace 130 into the inner chamber region 245. The sealing ball 260, which sits on the valve seat 265 and thus blocks fluid flow from the inner chamber region 245 through the inner fluid port 255 (effectively closing the inner fluid port 255), thus prevents flow of gas propellant from the headspace into the liquid flow path through the fluid flow valve housing 220 and the stem valve assembly housing 150. That is to say, gas from the headspace 130, which may, via the wall fluid ports 270, pass into the inner chamber region 245 cannot pass through the inner fluid port 255 and towards (or into) the fluid communication passageways 290 due to the sealing ball 260 abutting against the valve seat 265. Aptly the sealing ball 160 may be sized to prevent or limit propellant gas entering into the inner chamber region 245 via the wall fluid ports 270 when the sealing ball 260 is disposed against the valve seat 265. The sealing ball 260 thus helps prevent or limit air surge and the like wherein pressurised gas rushes through the liquid flow path of the valve arrangement 199 so that, when actuated, the fluid dispensing device only dispenses, and thus wastes, propellant gas. Furthermore, any high-pressure gas located in the inner chamber region 245 (from the headspace 130 via the wall side ports 170) may impart a pressure on the sealing ball 260, urging the sealing ball 160 against the valve seat 265 and may increase the fluid sealing effect of the sealing ball 160 against the valve seat 265.

[0096] Figure 6 illustrates a different perspective view of a partial section the valve arrangement 199 of Figures 5a and 5b when the fluid dispensing device 100 of Figure 1 is arranged in the upright orientation 305, 370 shown in Figures 3a and 3j. The arrows shown in Figure 6 help illustrate the liquid fluid flow path for liquid to be dispensed when the fluid dispensing device 100 is in an upright position or orientation 305, 370.

[0097] It will be appreciated the speed of the product (liquid fluid) coming up through the dip-tube is relatively slow due to the product smallest orifice, which is the stem fluid inlet (or alternatively the inner stem channel) being smaller than the dip-tube. Optionally the stem fluid inlet has a diameter of around 0.50 mm. Optionally the dip-tube has an inner diameter of around 3.45 mm. Optionally any other suitable dimensions may be utilised. Using these exemplary dimensions, the velocity of the fluid coming up the dip tube can be shown to be around 9.348 $mm^2 \div 0.785\ mm^2$ and is thus 11.90 times slower than that flowing through the stem orifice.

[0098] It will be appreciated that gravity and the density of the sealing ball is enough (or almost enough) to hold the ball on the seat even if the pressure differential (between the inside of the can of the fluid dispensing device and outside of the fluid dispensing device) is not evident after opening the valve.

[0099] Figure 7a illustrates the valve arrangement 199 of Figure 2 in cross section and in the orientation 310, 360 shown in Figures 3b and 3i. The valve arrangement 199 shown in Figure 7a is thus arranged in a diagonally tilted, but substantially upright, orientation 310, 360 where the axis associated with the valve stem 135 is offset from the primary valve stem axis 140 shown in Figure 1 by 45 degrees. That is to say that the angle of the primary stem axis of the fluid dispensing device of Figure 7a makes an of around 45 degrees with the primary stem axis 140 of the upright orientation shown in Figure 1. That is to say that, in the position shown in Figure 7a, the fluid dispensing device 100 has been tilted by an angle of around 45 degrees with respect to the upright position or orientation 305 270 shown in Figures 3a and 3j. The arrows of Figure 7 indicate liquid flow through the valve arrangement 199 when the stem 135 is depressed into an open configuration, shown in Figure 7a. As is shown in Figure 7, with similarity to the orientation 305, 370 of the valve arrangement 199 discussed with respect to Figures 5a and 5b, the flow path of liquid through the valve arrangement 199 is substantially the same as that described with respect to Figure 5a.

[0100] Figure 7b illustrates how gas flow occurs through the valve arrangement 199 of Figure 7a. Figure 7b shown the valve arrangement 199 in cross section. The arrows of Figure 7b indicate gas flow through the valve arrangement 199. As illustrated in Figure 7b, gas flow through the valve arrangement 199 when the fluid dispensing device is arranged in the diagonally tilted, but substantially upright, orientation 310, 360 shown is substantially the same as that discussed with respect to Figure 5b.

[0101] It will be understood that, alongside illustrating the valve assembly 199 when the fluid dispensing device 100 is tilted away from the upright orientation 305, 370 by 45 degrees, Figures 5a and 5b also illustrate the valve assembly 199 when the fluid dispensing device is tilted away from an inverted orientation 325, 330 (shown in Figures 3e and 3f) by 135 degrees as per the orientation 360 of the fluid dispensing device 100 shown in Figure 3i.

[0102] Figure 8 illustrates a schematic view of the sealing ball 260 and valve seat 265 of the fluid dispensing device in more detail. It will be understood that the sealing ball 260 and valve seat 265 shown in Figure 8 are in a position that corresponds with the orientation 310, 360 of the fluid dispensing device shown in Figures 3b, 3i. As shown in Figure 8, the sealing ball 260 sits flush against the valve seat 265 to fluidly seal, or substantially fluidly seal, the region around the valve seat 265. It will be appreciated that the sealing ball 260 thus acts to fluidly disconnect, or substantially fluidly disconnect, the inner chamber region 245 from the inner fluid port 255 of the valve arrangement 199 of Figure 2.

[0103] As is illustrated in Figure 8, when the valve seat 265 is tilted (such as in the position shown in Figure 8) relative to the position of the valve seat 265 when the fluid dispensing device 100 is in the upright position 305, 370 (as is shown in Figures 1, 3a and 3j) the weight of the sealing ball 260 acts in a direction that is oblique with respect to the axis along which the stem extends, that is a stem axis, when the fluid dispensing device 100 is in the orientation 310, 360. It will be understood that this axis makes an angle of 45 degrees with the primary stem axis shown in Figure 1. It will also be understood that the inner chamber region 245 and valve seat 265 are arranged around the axis along which the stem extends. It will be appreciated that the weight of the sealing ball 260 extends along the primary stem axis 140 shown in Figure 1 (which is the stem axis 140 when then fluid dispensing device 100 is disposed in an upright orientation 305, 370) pointing downwards (towards the ground) when the sealing ball 260 is sealingly engaged with the valve seat 265.

[0104] Respective force components of the weight of the sealing ball 160 (which act along the stem axis (W_x) at a given orientation of the fluid dispensing device 100 upon which the centre of mass of the sealing ball 260 is located when the sealing ball 260 sits on the valve seat 265, and act perpendicular to the stem axis (W_y)) can thus be resolved. The force components of the weight of the sealing ball are $Wx=W\cos(\theta)$ (extending along the stem axis) and $Wy=W\sin(\theta)$ (extending perpendicular to the stem axis).

[0105] It will be understood that various orientations of the fluid dispensing device 100 impact the position of the sealing ball 260 relative to the valve seat 265. Various force components and the associated position of the sealing ball 260 are indicted in Table 1 when the orientation of the fluid dispensing device 100 is such that the stem axis (along which force component W_x extends) makes an angle of θ with a directly downward direction that is the direction in which the weight of the sealing ball 160 acts by gravity. It will be appreciated that the orientations described in Table 1 relate to rotating the fluid dispensing device 100 away from an upright orientation 305, 370 and towards an inverted orientation 325, 330.

Table 1

θ (°)	W_x	W_y	Comments
15	0.97W	0.26W	Wx > Wy thus the sealing ball, by gravity, sits against the valve seat.
30	0.87W	0.50W	Wx > Wy thus the sealing ball, by gravity, sits against the valve seat.
44	0.72W	0.69W	Wx > Wy thus the sealing ball, by gravity, sits against the valve seat.
45	0.71W	0.71W	Wx = Wy thus the sealing ball will move away from its sealing position fully against the valve seat if angle θ is increased by rotating the fluid dispensing arrangement.
46 to 90	0.69W	0.72W	Wx <Wy thus the sealing ball starts moving in the inner chamber region away from its sealing position on fully against the valve seat.

[0106] Force components relating to the weight of the sealing ball 260 and comments regarding the position of the sealing ball 260 relative to the valve seat 265 at a variety of orientations of the fluid dispensing device 100 of Figure 1 where the stem axis of the fluid dispensing device 100 makes an angle θ with a downward direction in which the weight of the sealing ball 260

acts.

[0107] As can be seen from Table 1, when the fluid dispensing device 100 is rotated at an angle of around 45 degrees from the upright position 305, 370 (as is shown in Figures 1, 3a and 3j), the fluid dispensing device 100 reaches a threshold position at which point any further rotation of the fluid dispensing device 100 relating to the upright position 305, 370 to increase the angle of rotation past 45 degrees will act to unseat the sealing ball 260 from the sealed position against the valve seat that is shown in Figures 1, 2, 5a, 5b, 7a and 7b. Thus, when the stem axis is rotated away from the upright orientation 305, 370 at an angle of greater than 45 degrees, the sealing ball 260 does not fully abut against the valve seat 265. If the sealing ball 260 is sized so as to block fluid flow through the wall fluid ports 270 when the sealing ball 260 is sat in a sealing position on the valve seat 265, rotating the fluid dispensing device 100 away from the upright orientation 305, 310 by greater than 45 degrees will act to effectively open the wall side ports 270.

[0108] It will be appreciated that the position of the sealing ball 260 relative to the valve seat 265 is responsive to gravity and optionally buoyancy.

[0109] Figure 8 also shows how the valve seat 265 includes an annular abutment surface 810 against which sealing ball 260 abuts when the sealing ball 260 is disposed in a sealing position against the valve seat 265. It will be understood that the abutment surface 810 surrounds circular opening that is the inner fluid port 255. As is shown in Figure 8, the annular abutment surface 810 is oblique with respect to the stem axis. That is to say that annular abutment surface 810 is sloped or slanted. Thus, when the sealing ball 260 sits in a sealing position on the valve seat 265, the sealing ball 260 partly intrudes through the valve seat 265 so that a portion of the sealing ball 260 is located in the inner fluid port 255. Aptly the oblique valve seat 810 makes an angle of between around 25 to 55 degrees with the stem axis. Aptly this angle is between 30 and 50 degrees. Aptly this angle is around 45 degrees. Aptly this angle is around 48 degrees. It will be appreciated that the angle of the valve seat may help increase sealing provided by the sealing ball and the valve seat (by allowing the sealing ball to intrude partly through the valve seat (partly into the inner fluid port) and also may help in allowing he sealing ball to fall off the valve seat at a desired orientation of the fluid dispensing device.

[0110] Figure 9a illustrates the valve arrangement 199 of Figure 2 in cross section when the fluid dispensing device 100 of Figure 1 is arranged in the substantially sideways orientation 315 shown in Figure 3c. It will be understood that the sideways or lateral orientation 315 of the fluid dispensing device 100 is an orientation 315 in which the fluid dispensing device 100 is rotated at 90 degrees relative to the upright position 305, 370 illustrated in Figures 1, 3a, and 3j. Figure 9a illustrates liquid fluid flow through the valve arrangement 199 in the sideways orientation 315. Fluid flow through the valve arrangement 199 is illustrated by the arrows in Figure 9a. As is shown in Figure 9a, liquid fluid flow through the valve arrangement 199 is substantially the same as the fluid flow path described with respect to Figure 5a.

[0111] As can be seen from Figure 9a, the sealing ball 260 has moved away from its sealing position against the valve seat 265. That is to say that the sealing ball 260 is not fully seated against the annular abutment surface 810 of the valve seat 265 in a sealing manner. This is due to rotation of the fluid dispensing device by more than 45 degrees away from the upright orientation 305, 370. It can be seen in Figure 9a that the sealing ball 260 has instead moved to be in contact with the inner wall 250 of the fluid flow valve housing 220 and is now only in contact with a portion of the valve seat 265. Thus, a gap 910 is present at the remaining portion the valve seat 265 against which the sealing ball 260 is no longer abutting. It will be appreciated that if the wall fluid port 270 is located below a liquid fluid reservoir 125 level when the fluid dispensing device 100 is arranged in a so-called sideways position 315 as is illustrated in Figure 9a, liquid fluid may ingress into the inner chamber region 245 and may escape from the inner chamber region 245 through the inner fluid port 255 via the gap 910 between the valve seat 265 and the sealing ball 260. Thus, even if the dip-tube 195 is wholly or intermediately located out of the fluid reservoir 125 due to a curvature of the dip-tube 195 or the like, some fluid may still be able to ingress into the fluid communication pathways 290 of the fluid flow valve housing 220, via the gap 910, and thus may be able to be dispensed in a similar manner as will be described with respect to the inverted orientation 325, 330 of the fluid dispensing device 100 that will be described below.

[0112] Figure 9b illustrates how gas flow occurs through the valve arrangement 199 of Figure 2 when the fluid dispensing device 100 is arranged in the sidewise orientation 315 shown in Figure 3c. It will be understood that Figure 9b illustrates the valve arrangement 199 in cross section. The arrows included in Figure 9b illustrate gas flow through the valve arrangement 199. As is shown in Figure 9b, gas flow through the valve arrangement 199 occurs in substantially the same manner as is described with respect to Figure 5a. It is noted that liquid fluid cannot pass through the gas inlet region 510, or does not easily pass through the gas inlet region 510, between the mounting cup 115 and the fluid flow valve housing 220. Thus, even when the valve arrangement 199 is disposed sideways as shown in Figure 9b, gas can enter the gas communication region 520 at the upmost portion of the gas inlet region 510 (from the sideways perspective view of the valve assembly illustrated in Figure 10a) that would be outside of the fluid reservoir 125 and in the headspace 130 in the can, and can pass around the stem valve assembly housing 150 to access the gas flow passageway 178 in the stem valve assembly housing 150 and enter into the stem channel 176 to mix with liquid fluid when the stem 135 is depressed.

[0113] Figure 10a illustrates the valve arrangement 199 of Figure 2 in cross section when the fluid dispensing device 100 of Figure 1 is in a tilted, but substantially downward facing, orientation 320, 340. The orientation of the valve arrangement 199 shown in Figure 10a is thus the orientation of the valve arrangement199 when the fluid dispensing device 100 is in the orientation 320, 340 shown in Figure 3d and 3g. It will thus be understood that the orientation of the valve arrangement 199 shown in Figure 10a is a position when the fluid dispensing device 100 is tilted away from the upright orientation 305, 370 by an angle of 135 degrees so that the stem axis makes an angle of around 135 degrees with the primary stem axis 140 (that is the stem axis when the fluid dispensing device 100 is in an upright orientation 305, 370) shown in Figure 1. when the fluid dispensing device is in an upright orientation 305, 370. That is to say that the position shown in Figure 10a shows the valve arrangement 199 when the fluid dispensing device is tilted around 135 degrees from the upright position as shown in Figure 3e. It will also be understood that the position of the valve arrangement 199 shown in Figure 10 is the position when the fluid dispensing device 100 is tilted away from an inverted orientation 325, 330 by 45 degrees as shown in Fight 3i.

[0114] In particular, Figure 10a illustrates how fluid flow occurs through the valve arrangement 199 when the fluid dispensing device 100 is in the orientation 320, 240 shown.

[0115] As shown in Figure 10a, the sealing ball 260 is in a different position relative to the position of the sealing ball 260 shown in Figures 5a, 5b, 5c, 7a and 7b, and also in Figures 9a and 9b. As is shown in Figure 10a, instead of being located proximate to the valve seat 265, the sealing ball 260 is located at the further end 1010 of the inner chamber region 245 against a rear surface 1020 of the spring seat 215 that is an opposite side of the spring seat 215 to the side that the spring 148 abuts against. That is to say that the sealing ball 260 is located against the rear surface 1020 of the spring seat 215 that forms a surface of the inner chamber region 245 at the further end 1010 of the chamber. It will be appreciated that the rear surface 1020 of the spring seat 215 is an example of a closure member support region. It will be appreciated that the rear surface 1020 of the spring seat 215 includes a generally concave central region 1030 around which an annular lip 1040 extends. As shown in the cross-sectional view shown in Figure 10a, the generally concave 1030 region has a generally arcuate cross section which extends between projecting cross sectional regions which correspond to the annular lip 1040.

[0116] Figure 10a shows how the annular lip 1040 on the rear surface 1020 of the spring seat 215 is sized to cooperate with the cylindrical inner surface 250 of the fluid flow valve housing 220 so that the annular lip 1040 sits inside an end region of the cylindrical inner surface 250. Outer walls of the annular lip region 1040 of the spring seat 215 thus abut against a portion of the cylindrical inner surface 250. It will be appreciated that the diameter of the outer surface of the annular lip 1040 is similar to the diameter of the inner cylindrical surface 250 so that the annular lip 1040 forms an interference fit with the inner surface 250 and thus connects the spring seat 215 to the fluid flow valve housing 220. As shown, an annular abutment surface is arranged radially outside of the annular lip 1040 which abuts against the inner cylindrical surface 250. The spring seat 215 and inner surface 250 thus partly surround the inner chamber region 245.

[0117] As is shown in Figure 10a the concave region 1030 on the rear surface 1020 of the spring seat 215 results in the inner chamber region 245 having a concave end region at the further end 1010 of the chamber. It will be understood that the sealing ball 260 is sized so that the sealing ball diameter is around the same size, or less than, the size of a diameter of the annular lip 1040 of the spring seat 215. The sealing ball 260 can therefore sit within the annular lip 1040 and can intrude into the concave end region, that is the concave region 1030 of the spring seat 215, when the sealing ball 215 is disposed at the further end 1010 of the inner chamber region 245. It will be understood that when the sealing ball 260 is disposed at the further end 1010 of the inner chamber region 245, within the annular lip 1040 and concave region 1030 of the rear surface 1020 of the spring seat 215, the sealing ball 260 is disposed away from the inner fluid port 255 and thus does not prevent fluid flow through said port. Similarly, the sealing ball 260 is distal to the wall ports 270 and thus does not prevent, or reduce, fluid flow through the wall ports 270.

[0118] It will be appreciated that the sealing ball 260 can be located in the position shown in Figure 10a by gravity. As previously discussed, when the fluid dispensing device 100 is tilted 45 degrees from the upright position as is shown in Figure 3c, the sealing ball 260 falls away from its sealing position against the valve seat 265 but remains in contact with a portion of the seat 265 (the portion of the seat closest to the ground) by gravity. It will be understood that the position of the valve arrangement 199 shown in Figure 3c is a threshold orientation where any further rotation of the fluid dispensing device 100 away from the upright orientation (and towards the inverted orientation), from the position of Figure 3c causes the sealing ball 260 to roll away from the valve seat 265 along a lower portion of the inner wall 250 by gravity. Thus, the sealing ball 260 rolls towards the further end 1010 of the inner chamber region 245 (towards the spring seat 215) and into the concave region 1030 of the rear surface 1020 of the spring seat 215 by gravity.

[0119] As shown in Figure 10a, the fluid flow path through the valve arrangement differs from the fluid flow path described with respect to Figures 5a, 5b, 5c, 7a, 7b, 9a and 9b. When the fluid dispensing device 100 is arranged in the orientation 320, 340 shown in Figures 3d and 3g, the fluid reservoir 125 settles substantially towards the upper end on the can (the end upon which the mounting cup 115 is secured). The wall fluid ports 270 of the fluid flow valve housing 220 are thus arranged beneath the level of liquid fluid in the can. Thus, liquid fluid from outside of the fluid flow valve housing 220, at a fluid communication region of the can that is outside of the fluid flow valve housing 220, flows through the wall fluid ports 270 into the inner chamber region 245. Liquid can then pass from the inner chamber region 245 through the inner fluid port 255, which is open as the sealing ball 260 is located at the further end 1010 of the inner chamber region 245 and into a first end 291 of each fluid communication passageway 290. The first end 291 of each fluid communication passageway 290 is located proximate to the open region 235 of the fluid flow valve housing 220. Liquid fluid thus can then pass through the fluid communication passageways 290 towards the further end 292 of the fluid communication passageways 290 (each disposed proximate to stem valve assembly housing 150). Liquid fluid then passes around the stem valve assembly housing 150 and into the stem 135 as has been described with respect to Figure 5a.

[0120] It will be appreciated that when sealing ball 260 is arranged towards the further end 1010 of the inner chamber region 245, the sealing ball 260 does not act to block or reduce fluid flow into the inner chamber region 245 via the wall fluid ports 270.

[0121] As shown by the arrows in Figure 10a, if the end of the dip-tube (that is not connected to the fluid flow valve assembly 220) is still immersed in the fluid reservoir 125 when the valve arrangement 199 is in the position shown in Figure 10a (which depends on the length and shape of the dip-tube 195 as well as how much liquid fluid is left in the can) some fluid may travel through the dip-tube 195 into the fluid flow valve housing 220 and thus may pass through the valve arrangement 199 as has been described with respect to Figure 5a. If however the end of the dip-tube 195 (that is not connected to the fluid flow valve assembly 220 and is distal to the fluid flow valve assembly 220) is not immersed in the fluid reservoir when the valve arrangement 199 is arranged in the position shown in Figure 10a (as is the case with respect to the fluid dispensing device 200 illustrated in Figures 3d and 3g), it will be understood that no fluid will pass into the fluid flow valve housing 220 via the dip tube 195.

[0122] Figure 10b illustrates how the propellant gas in the can headspace 130 acts when the valve arrangement 199 is arranged in the orientation shown in Figure 10a. Figure 10b shows the valve arrangement 199 in cross section. As shown with respect to Figures 3d and 3g, when the fluid dispensing device 100 is in the oblique or tilted and substantially downward facing orientation 320, 340 (relative to the upright orientation 305, 370), the liquid fluid reservoir 125 settles towards the top of the can (where the mounting cup 115 is arranged) and the headspace 130 which contains the propellant gas is arranged above the fluid reservoir 125 (as the propellant gas is less dense than the liquid fluid) towards the bottom end of the can (which from the perspective view shown in Figures 3d and 3g is in a substantially upward direction). The propellant gas thus provides a pressure on the fluid reservoir 125 and forces liquid fluid to flow through the valve arrangement 199 as described above with reference to Figure 10a. The gas provides a substantially equal pressure on the fluid reservoir 125 across the surface of the settled liquid fluid reservoir 125. Gas however is separated from the stem valve assembly housing 150 in the orientation of the valve arrangement 199 shown in Figure 10b. Thus no gas enters the stem 135 or is dispensed from the device 100 when the stem 135 is depressed (or urged towards the stem valve assembly housing 150) when the fluid dispensing device 100 is in the orientation 320, 340 shown in Figures 3d and 3g. Thus, in the orientation of the valve arrangement 199 shown in Figure 10b no gas is dispensed when the device is actuated, only liquid is dispensed.

[0123] Figure 11 illustrates how the sealing ball 260 sits against the rear surface 1020 of the spring seat 215 when the valve arrangement 199 is arranged in the orientation shown in Figures 10a and 10b. Figure 11 illustrates the sealing ball 260 and sealing ball support surface of the spring seat 215 in more detail. It will be understood that the sealing ball 260 and spring seat shown in Figure 11 are in a position that corresponds with the orientation of the fluid dispensing device 100 shown in Figures 3d, 3g. Figure 11 thus illustrates how the sealing ball 260 sits against the rear surface 1020 of the spring seat 215 when the valve arrangement 199 is arranged in the orientation shown in Figures 10a and 10b. As shown in Figure 11, the sealing ball 260 sits within the annular lip 1040of the spring seat rear surface 1020 and intrudes into the concave region 1030 of the spring seat rear surface 1020 at the further end 1010 of the inner chamber region 245. The sealing ball 260 is thus disposed distal to the inner fluid port 255 and the wall fluid ports 270. It will be appreciated that this acts to fluidly connect the inner chamber region 245 with the inner fluid port 255 (and wall fluid ports 270 should the sealing ball be sized to effectively close the wall fluid ports 270 from the inner chamber region 245 when the sealing ball is disposed against the valve seat 265).

[0124] As is illustrated in Figure 11, in the orientation 320, 340 of the fluid dispensing device 100 shown in Figures 3d and 3g, the weight of the sealing ball 260 acts in a direction that is oblique with respect to the stem axis along which the stem extends in this particular orientation of the device It will be understood that the inner chamber region 245 and spring seat 215 are arranged on, and are substantially symmetrical around, this stem axis. Respective force components which act along the stem axis (W_x;upon which the centre of mass of the sealing ball is located when the sealing ball is arranged within the annular lip 1040 of the spring seat rear surface 1020), and act along an axis that is extends through the centre of mass of the sealing ball and is perpendicular to the stem axis (W_y) can thus be resolved. The force components of the weight of the sealing ball are $Wx=W\cos(\theta)$ (extending along the stem axis) and $Wy=W\sin(\theta)$ (extending perpendicular to the stem axis).

[0125] It will be understood that various orientations of the fluid dispensing device 100 impact the position of the sealing ball 260 relative to the spring seat support surface. Various force components and the associated position of the sealing ball 260 are indicted in Table 2 wherein the orientation of the fluid dispensing device 100 is such that the stem axis (along which force component W_x extends) makes an angle of θ with a directly downward direction that is the direction in which the weight of the sealing ball acts by gravity. It will be appreciated that the orientations in Table 2 relate to rotating a fluid dispensing device away from an inverted orientation 325, 330 and towards an upright orientation 305, 370.

Table 2

θ (°)	W_x	W_y	Comments
15	0.97W	0.26W	Wx > Wy thus the sealing ball, by gravity, sits against closure element support surface in the annular lip.
30	0.87W	0.50W	Wx > Wy thus the sealing ball, by gravity, sits against closure element support surface in the annular lip.
44	0.72W	0.69W	Wx > Wy thus the sealing ball, by gravity, sits against closure element support surface in the annular lip.
45	0.71W	0.71W	Wx = Wy thus the sealing ball will move away from the closure element support surface by falling out of the annular lip if angle θ is increased by rotating the fluid dispensing arrangement towards the upright position.
46 to 90	0.69W	0.72W	Wx <Wy thus the sealing ball moves away from the closure element support surface and falls out of the annular lip.

[0126] Force components relating to the weight of the sealing ball 260 and comments regarding the position of the sealing ball 260 relative to the sealing ball support region at a variety of orientations of a fluid dispensing device 100 where a stem axis of the fluid dispensing device 100 makes an angle θ with a downward direction in which the weight of the sealing ball 260 is directed.

[0127] As can be seen from Table 2, when the fluid dispensing device 100 is rotated at an angle of around 45 degrees from an inverted orientation the fluid dispensing device 100 reaches a threshold position at which point any further rotation of the fluid dispensing device from the inverted orientation 325 330 towards the upright position 305, 370 will act to move the sealing ball 260 away from the closure element support surface so that the sealing ball falls out of the annular lip 1040 if the spring seat 215.

[0128] Figure 12a illustrates the valve arrangement 199 of Figure 2 in cross section when the fluid dispensing device 100 of Figure 1 is arranged in an inverted orientation 325, 330. It will be understood that the inverted position is shown in Figures 3e and 3f. In particular, Figure 12a illustrates fluid flow through the valve arrangement 199 when the fluid dispensing device 100 is arranged in an inverted orientation 325, 330. The arrows in Figure 12a indicate how fluid flow occurs through the valve arrangement 199. As can be seen in Figure 12a, liquid fluid flow through the valve arrangement 199 in the inverted orientation shown is substantially the same as liquid flow described with respect to Figure 10a.

[0129] It is noted that, in the inverted orientation 325, 330 the dip-tube 195 is arranged outside of the fluid reservoir 125 and in the headspace 135. This can be seen in Figures 3e and 3f.

[0130] Thus, no liquid fluid flows through the dip-tube 195 and into the fluid flow valve assembly 199.

[0131] Figure 12b illustrates propellant gas behaviour when the fluid dispensing device 100 is arranged in the inverted orientation 325, 330 as shown in Figures 3e and 3f. Figure 12b illustrates the valve arrangement 199 in cross section in the position shown in Figure 12a. As is shown in Figure 12b, the propellant gas behaves in substantially the same manner as is described with respect to Figure 10b.

[0132] Figure 13 illustrates a different perspective partial section view of the valve arrangement 199 of Figure 2 when the fluid dispensing device of Figure 1 is in an inverted orientation 325, 330. The arrows in Figures 13 help illustrate liquid fluid flow through the valve arrangement 199 when the fluid dispensing device 100 is in the inverted orientation.

[0133] It will be appreciated that the can may have an inner pressure of 8.0 bar or 4.0 bar or 2.0 bar, for example. It will be understood that the pressure, when the can (or fluid dispensing device) is inverted is operating on all regions of the surface of the fluid reservoir equally including any residual liquid in the dip-tube, the liquid in the can breast and the liquid in the wall fluid ports until the stem urged into an open position and a pressure drop occurs. Thus, this pressure allows liquid which ingresses into the inner chamber region via the wall fluid ports (when the fluid dispensing device is in an inverted orientation) to effectively travel upwards against gravity to pass through the inner fluid port and reach the fluid communication pathways.

[0134] It will be appreciated that fluid flow through the valve arrangement in an upright orientation, that is a first orientation, corresponds to a first mode of operation of the valve arrangement. It will be appreciated that fluid flow through the valve arrangement in an inverted orientation, that is a further orientation, corresponds to a further mode of operation of the valve arrangement.

[0135] Figure 14a illustrates the valve arrangement 199 of Figure 2 in cross section when the fluid dispensing device 100 of Figure 1 is in the substantially sideways or lateral orientation 350 shown in Figure 3h.. In particular, Figure 10a illustrates how liquid fluid flow occurs through the valve arrangement 199 when the fluid dispending device 100 is in the sideways orientation 350 of Figure 3h. The arrows in Figure 14a illustrate fluid flow. It will be appreciated that the orientation of the valve arrangement 199 shown in Figure 14a is substantially the same as the orientation shown in Figures 9a and 9b however, the sealing ball 260 in the arrangement shown in Figure 14a is different position that in the orientation shown in Figures 9a and 9b. As is shown in Figure 14a, instead of being located proximate to the valve seat 265 the sealing ball 260 is located at the further end 1010 of the inner chamber region 245 against the closure element support surface. It will be understood that the sealing ball 260 may alternatively fall out of the annular lip 1040 and be disposed against a lower portion of inner wall 250. This may depend on the pressure incident on the sealing ball and may depend on the weight of the sealing ball or the buoyancy of the sealing ball and the like. This may also depend on the amount of fluid and/or gas located in the inner chamber region 245. It will be understood that the sideways orientation of Figure 14a occurs when the fluid dispensing device 100 is tilted from the inverted orientation 325, 330 towards the upright orientation 305, 370 by 90 degrees.

[0136] Figure 14a illustrates how liquid fluid flow occurs through the valve arrangement 199. The arrows in Figure 14a illustrate liquid fluid flow through the valve arrangement. It will be understood that liquid fluid flow through the valve arrangement 199 in the orientation shown in Figure 14a is substantially the same as is described with respect to Figure 5a.

[0137] Figure 14b illustrates how gas flow occurs through the valve arrangement 199 of Figure 2 in the sideways orientation shown in Figure 14a. The valve arrangement is shown in cross section in Figure 14b. The arrows in Figure 14b illustrate gas flow through the valve arrangement 199. It will be understood that gas flow through the valve arrangement 199 in the orientation shown in Figure 14a is substantially the same as described with respect to Figure 5a.

[0138] Figure 15a illustrates an alternative inner chamber region 1510 in cross section that may be utilised in the valve arrangement 199 of Figure 2 of the fluid dispensing device 100 of Figure 1. As is shown in Figure 15a, the alternative inner chamber region 1510 includes a wall side port 1520 with a substantially rectangular cross section and an inner fluid port 1530 (and valve seat 540 in which a sealing ball 1545 can sit) that is off-centre with respect to the inner chamber region 1510.

[0139] Figure 15b illustrates a schematic view of an alternative valve seat 1550 that may be utilised in the valve arrangement 199 of Figure 2 of the fluid dispensing device 100 of Figure 1. As shown in Figure 15b, the valve seat 1550 does not include an abutment surface that is oblique to a stem axis. Instead, the valve seat 1550 includes a through hole 1555 through a substantially square bottom wall 160 of an inner chamber region 1565 that is sized to be slightly smaller than a diameter of a sealing ball 1570 that can sit within the hole 1555. It will be understood that the hole 1555 though the bottom wall 1560 of the inner chamber region 1565 is an inner fluid port. Thus, when the sealing ball 1570 is disposed in a sealing position against the valve seat 1550, the sealing ball 1570 sits in the hole 1555 and blocks fluid flow through the inner fluid port.

[0140] Figure 15c illustrates schematic view of an alternative inner chamber region that may be utilised in the valve arrangement 199 of Figure 2 of the fluid dispensing device 100 of Figure 1. As is shown in Figure 15c, an inner wall region 1582, or a portion of an inner wall, of the inner chamber region 1580 is oblique with respect to the major axis associated with the inner chamber region 1580. Thus, this inner wall region 1582, that is a slanted wall region, is oblique with respect to a respective stem axis in a valve assembly. As shown in Figure 15c, the slanted wall region 1582 is flared out towards an upper end 1584 of the inner chamber region 1580 (distal to an inner fluid port 1586 in a bottom end of the inner chamber region) so that the inner chamber region 1580 is narrower towards an end 1588 of the inner chamber region 1580 that includes the inner fluid port 1586 (and a valve seat 1589), and widens towards the upper end 1584 of the inner chamber region 1584. The slanted wall region 1582 shown in Figure 15c is oblique to an axis 1590 that is parallel with the stem axis and that touches the innermost part of the slanted wall region 1582 (at the lowest end of the slanted wall region) so that the slanted wall region 1582 makes an angle of 10 degrees with the axis 1590. Alternatively, any angle between 0 and 10 degrees could be utilised. It will be understood that such a slanted wall region 1582 results in a sealing ball 1592 rolling towards the upper end 1584 of the inner chamber region 1580 when a fluid dispensing device is tilted at an angle that is less than 90 degrees from the upright orientation. Although Figure 15 illustrates the valve seat 1586 of Figure 15b being utilised alongside the slanted wall region 1582, it will be appreciated that a slanted wall region could be utilised in the inner chamber region 245 of the valve arrangement 199 shown in Figures 1 to 14.

[0141] Figure 16 illustrates a top-down perspective view of the fluid flow valve housing 220 and the spring seat 215 of the valve arrangement 199 of Figure 2. Figure 16 helps illustrate how the spring seat is mounted in the fluid flow valve housing 220.

[0142] Figure 17 illustrates a side-on perspective view of the fluid flow valve housing 220 of the valve arrangement 199 of Figure 2 in cross section. Figure 17 helps illustrate how the wall side ports 270 extend wholly through a portion of the fluid flow valve housing 220 from (and through) the inner surface 250, that at least partly boundaries the inner chamber region 245 to (and through) an outer surface 1710 if the fluid flow valve housing 220. Figure 17 also indicates how the fluid communication passageways 290 do not intersect the wall side ports 270. Figure 17 helps illustrate how the two wall fluid ports 270 are each arranged at substantially opposite sides of the fluid flow valve housing 220.

[0143] Figure 18 illustrates a different perspective view of the fluid flow valve housing 220 of the valve arrangement 199 of Figure 2 in cross section. It will be appreciated that the perspective view shown in Figure 18 is a 45 degree rotation (about a major axis of the fluid flow valve housing that corresponds with the primary stem axis 140 shown in Figure 1) of the fluid flow valve housing 220 relative to the perspective view of Figure 17. Figure 18 helps illustrate how the two fluid communication passageways 290 are arranged at substantially opposite sides of the fluid flow valve housing 220. The arrows in Figure 18 illustrate how liquid fluid flow occurs through the fluid flow valve 220 housing when the fluid dispensing device 100 is in a substantially upright orientation 305, 370.

[0144] Figure 19 illustrates a still further perspective view of the fluid flow valve housing 220 of the valve arrangement 199 of Figure 2. Figure 19 helps illustrate how the fluid communication passageways 290 extends through the housing 220 and are radially outside of the inner chamber region 245. The arrows in Figure 19 illustrate how liquid fluid flow occurs through the fluid flow valve housing 220 when the flid dispensing device 100 is in a substantially upright orientation 305, 370.

[0145] Figure 20 illustrates another perspective view of the fluid flow valve housing 220 of the valve arrangement 199 of Figure 2. Figure 20 illustrates how the fluid communication passageways 290 extend around respective wall port blocks 2010 that are solid parts of the fluid flow valve housing 220 through which the respective wall fluid ports 270 extend. The arrows in Figure 20 illustrate how liquid fluid flow occurs through the fluid flow valve housing 220 when the fluid dispensing device 100 is in a substantially upright orientation 305, 370.

[0146] Figure 21 illustrates a different perspective view of the fluid flow valve housing 220 of the valve arrangement 199 of Figure 2. Figure 21 illustrates how the fluid communication passageways 290 extend around respective wall port blocks 2010 that are solid parts of the fluid flow valve housing 110 through which the respective wall fluid ports extend 270. The arrows in Figure 21 illustrate how liquid fluid flow occurs through the fluid flow valve housing 220 when the fluid dispensing device 100 is in a substantially upright orientation 305, 370.

[0147] Figure 22 illustrates a bottom-up perspective view of the fluid flow valve housing 220 of the valve arrangement 199 of Figure 2. Figure 22 helps illustrate how the inner fluid port 255 is arranged at the first end, that is a bottom end, of the inner chamber region 245.

[0148] Figure 23 illustrates a different bottom-up perspective view of the fluid flow valve housing 220 of the valve arrangement 199 of Figure 2. Figure 23 helps illustrate how the inner fluid port 255 is arranged at the first end, that is a bottom end, of the inner chamber region 245.

[0149] Figure 24 illustrates a schematic top-down view of the two fluid communication passageways 290, the inner chamber region 245 and the two wall ports 270 that are disposed in the fluid flow valve housing 220. Figure 24 helps illustrates how the two fluid communication passageways 290 are arranged at substantially opposite sides of the fluid flow valve housing 220 and are generally arcuate in cross section. Figure 24 also helps illustrate how the two fluid flow passageways 290 are not disposed on the same sides of the fluid flow valve housing 220 as the wall fluid ports 270. The fluid flow passageways thus do not intersect the wall fluid ports 270. The two wall fluid ports 270 are instead disposed in respective wall fluid port blocks 2010 that are each arranged on substantially opposite sides of the fluid flow valve housing 220.

[0150] Figure 25a illustrates a schematic view of the valve arrangement 199 of Figure 2 in cross section that is in a substantially upright orientation. It will be understood that the valve arrangement 199 illustrated in Figure 25a is in a closed configuration. That is to say the stem 135 is biased upwards by the spring 148 so that the stem shoulder 165 abuts against the inner lip 270 of the stem valve assembly housing 150. Figure 25a helps illustrate how the stem fluid inlet 175 and the stem gas inlet 179 are fluidly disconnected from the fluid flow path and gas flow path respectively when the stem 135 is in a closed configuration.

[0151] Figure 25b illustrates a schematic view in cross section of the valve arrangement 199 of Figure 2 in an upright position and in an open configuration. It will be understood that an external force has urged the stem 135 downwards. Figure 25b helps illustrate how the stem fluid inlet 175 and stem gas inlet 179 are fluidly connected to the fluid flow path and gas flow path respectively when the stem is in the open configuration.

[0152] Figure 25c illustrates a schematic view of the valve arrangement 199 of Figure 2 in cross section in an inverted orientation. It will be understood that, as well as being inverted, the perspective view of Figure 25c is a 45 degree rotation about the primary stem axis 140 shown in Figure 1 relative to the perspective view shown in Figure 25b. Figure 25c helps illustrate how the two wall fluid flow ports 270 extends through valve blocks 2010 that are disposed on opposite sides of the fluid flow valve housing 220.

[0153] Figure 26a illustrates a perspective view of the assembled valve arrangement 199 of Figure 2. Figure 26a helps illustrate how the fluid flow valve housing 220 is connected below a stem valve assembly housing 150 around which a mounting cup 115 is arranged.

[0154] Figure 26b illustrates a top-down perspective view of the valve arrangement 199 of Figure 2.

[0155] Figure 26c illustrates a bottom-up perspective view of the valve arrangement 199 of Figure 2.

[0156] Figure 26a illustrates a top-down perspective view of the spring seat 215 of the valve arrangement 199 of Figure 2. Figure 26a helps illustrate how the spring seat 215 includes a spring cavity 2710 in which the spring 148 is arranged. A number of spring support elements 2720 help support the spring in the correct position.

[0157] Figure 26b illustrates a side-on perspective view of the spring seat 215 of the valve arrangement 199 of Figure 2. Figure 26b helps illustrate how the spring seat includes an annular lip 1040 on its rear surface for receiving the sealing ball 260.

[0158] Figure 26c illustrates bottom-up perspective view of the spring seat 215 of the valve arrangement 199 of Figure 2.

[0159] Figure 26d illustrates a perspective view of the spring seat 215 of the valve arrangement 199 of Figure 2 in cross section. Figure 26d helps illustrate how the rear surface 1020 of the spring seat includes a concave region 1030 into which the sealing ball 260 can intrude in use.

[0160] Figure 26e illustrates a further perspective view of the spring seat 215 of the valve arrangement 199 of Figure 2. Figure 26e helps illustrate the spring cavity 2710 on the top region 2730 of the spring seat 215 into which the spring 148 can be arranged.

[0161] Figure 27a illustrates a top-down perspective view of the stem valve assembly housing 150 of the valve arrangement 199 of Figure 2.

[0162] Figure 27b illustrates a side on perspective view of the stem valve assembly housing 150 of the valve arrangement 199 of Figure 2. Figure 27b helps illustrate how a gas flow passageway 178 is arranged in the stem valve assembly housing 150 that forms part of a gas flow path between the headspace region 130 of the can and the stem channel 176.

[0163] Figure 27c illustrates a bottom-up perspective view of the stem valve assembly housing 150 of the valve arrangement 199 of Figure 2.

[0164] Figure 27d illustrates the stem valve assembly housing 150 of the valve arrangement 199 of Figure 2 in cross section. Figure 27d helps illustrate how the stem valve assembly housing 150 includes a bore 2810 in which the stem 135 is arranged in use. Figure 27d also includes two circled regions denoted by B and C respectively.

[0165] Figure 27e illustrates a cross sectional view of the circled region denoted by C in more detail. Figure 27e helps illustrate how a connecting portion 2820, that is a narrowed lower portion, of the stem valve assembly housing 150 includes a number of outwardly extending circumferential ribs or ridges 232 that help secure the stem valve assembly housing to the open mouth 225 of the fluid flow valve housing 220 that has corresponding grooves 233.

[0166] Figure 27f illustrates a cross sectional view of the circled region denoted by B in more detail. Figure 27f helps illustrate how the stem valve assembly housing 150 includes an inwardly facing lip 170 that helps fluidly disconnect the stem channel 176 from the stem valve assembly housing. Figure 27f also helps illustrate how a gas flow region 530 is located underneath in the space where the inner sealing gasket 120 is arranged in use. This gas flow region 530 helps transport gas from the gas flow passageway 178 to the stem channel 176 when the stem 135 is in an open configuration.

[0167] Figure 28g illustrates a different perspective view of the stem valve assembly housing 150 of the valve arrangement 199 of Figure 2.

[0168] Figure 29a illustrates a cross sectional view of the valve arrangement 199 of Figure 2 in an upright orientation when the stem 135 is arranged in a closed configuration.

[0169] Figure 29b illustrates a cross sectional view of the valve arrangement 199 of Figure 2 in an upright orientation when the stem 135 is arranged in a closed configuration. It will be appreciated that the viewpoint shown in Figure 29b is a 45 degree rotation about the stem axis 140 relative to the valve assembly shown in Figure 29a.

[0170] Figure 29c illustrates a cross sectional view of the valve arrangement 199 of Figure 2 in an upright orientation when the stem 135 is in an open configuration. It will be appreciated that, other than the valve arrangement 199 being in an open configuration, the viewpoint shown in Figure 29c is the same viewpoint shown in Figure 29a.

[0171] Figure 29d illustrates a cross sectional view of the valve arrangement 199 of Figure 2 in an invented orientation when the stem is in a closed configuration. It will be appreciated that, other than the valve assembly being inverted, the viewpoint shown in Figure 29c is the same viewpoint shown in Figure 29b.

[0172] Figure 30a illustrates a perspective view of the assembled valve arrangement 199 of Figure 2. Figure 26a helps illustrate how the fluid flow housing is connected below a stem valve assembly housing around which a mounting cup is arranged.

[0173] Figure 30b illustrates a bottom-up perspective view of the valve arrangement 199 of Figure 2.

[0174] Figure 30c illustrates a top-down perspective view of the valve arrangement 199 of Figure 2.

[0175] Figure 30d illustrates a different perspective view of the valve arrangement f Figure 2. Figure 30d helps illustrate how the wall fluid ports 270 extend through the outer surface of the fluid flow valve housing 220.

[0176] Figure 31a helps illustrate how the valve arrangement 199 of Figure 2 can be assembled. As shown in Figure 31a, the spring seat 215, which includes a spring cavity on the top surface of the spring seat 215 in which the spring 148 is arranged, is provided through the open mouth region of the fluid flow valve housing 220 so that the spring seat 215 closes the top end, which is the further end, of the inner chamber region 245 located in the main body portion of the fluid flow valve housing 220. It will be appreciated that the annular rib located on the rear surface of the spring seat 215 is arranged to be within an end portion of the cylindrical inner surface of the fluid flow valve housing 220 that partly surrounds the inner chamber region. It will also be understood that prior to arranging the spring seat 215 in the fluid flow valve housing 220, the sealing ball 160 is provided through the upper end, that is the further end, of the inner chamber region 245 so that the sealing ball 260 is disposed within the inner chamber region 245.

[0177] An outer sealing gasket 218 is arranged inside an outer circumferential wall of a mounting cup 115 that is crimped into the top of the stem valve assembly housing 150. The stem valve assembly, that is surrounded by the mounting cup 115, is connected to the open mouth of the fluid flow valve housing 220 via a connecting portion of the stem valve assembly housing 250. This is done either before or after or simultaneously with the outer gasket 218 being provided to the mounting cup 115.

[0178] Figure 31b illustrates a perspective view of the assembled valve arrangement 199 in cross section. It will be understood that the assembled stem valve arrangement 199 shown in Figure 31b is thus described above with reference to Figure 2.

Claims

1. Apparatus for dispensing fluid, comprising:

a housing member (220), wherein at least one inner wall (250) of the housing member (220) at least partly surrounds an inner chamber region (245) that is disposed within a main body portion of the housing member (220), an inner fluid port (255) being disposed at a first end region of the inner chamber region (245) and in fluid communication with an open region (235) of the housing member (220) disposed at a first end region of the housing member;

at least one fluid communication passageway (290) disposed within the main body portion and comprising a first end of the at least one fluid communication passageway proximate to the open region (235), and a remaining end of the at least one fluid communication passageway, proximate to a further end of the housing member, that is spaced apart from the first end region of the housing member, the at least one fluid communication passageway (290) being disposed radially outside the inner chamber region (245) and being in fluid communication with the open region (235);

at least one wall fluid port (270) extending through the inner wall (250) and through an outer surface of the housing member (220) to fluidly connect a fluid communication region located outside of the housing body and the inner chamber region (245); and

a closure element (260) disposed in, and movable within, the inner chamber region (245) to selectively limit fluid flow through the inner fluid port (255); wherein

the housing member (220) is connected to, or is integrally formed with, a valve assembly (150) that includes an elongate valve stem (135) associated with a respective stem axis (140) and a stem housing that radially surrounds at least a portion of the elongate valve stem (135), the stem housing comprising at least one stem housing fluid communication region (149) that is in fluid communication with the at least one fluid communication passageway (290) and is fluidly connectable to an inner stem channel (176) disposed along at least a portion of the elongate valve stem (135), the stem housing further comprising at least one gas communication region (520) that is fluidly connectable to the inner stem channel (176) so that at least one fluid and at least one gas are mixable in the inner stem channel (176).

2. The apparatus as claimed in claim 1, wherein
the elongate valve stem (135) comprises a fluid inlet (175) in fluid communication with the inner stem channel (176) and selectively connectable with the stem housing fluid communication region (149), and a stem gas inlet (179) in fluid communication with the inner stem channel (176) and selectively connectable with the at least one gas communication region (520), the fluid inlet (175) being disposed to be fluidly connected with the stem housing fluid communication region (149) at the same time as the stem gas inlet (179) is fluidly connected with the at least one gas communication region (520) to provide a fine spay in the inner stem channel (176) by two fluid atomisation.

3. The apparatus as claimed in claim 1 or claim 2, further comprising:
a valve seat region (265) disposed within the inner chamber region (245) proximate to the inner fluid port (255), the closure element (260) being locatable against the valve seat region (265) for preventing fluid flow through the inner fluid port (255) when the housing member (220) is disposed in a first orientation.

4. The apparatus as claimed in any preceding claim, further comprising:

a closure element support region (257) disposed at a further end region (257) of the inner chamber region (245) that is spaced apart from the first end region of the inner chamber region (245), the closure element (260) being locatable against the closure element support region (257) to permit fluid flow through the inner fluid port (255) when the housing member (220) is disposed in a further orientation,

optionally wherein the closure element (260) has a maximum width that is smaller than a maximum width of a region of the inner chamber region (245) in which the closure element (260) is movable in operation.

5. The apparatus as claimed in claim 4 when dependent on claim 3, wherein
the closure element (260) has a maximum width that is smaller than a maximum width of a region of the inner chamber region (245) between the valve seat region (265) and the closure element support region (257).

6. The apparatus as claimed in any preceding claim, wherein

the housing member (220) is connected to the valve assembly (150) at a further end region of the housing member (220) that is spaced apart from the first end region of the housing member (220),

optionally wherein the inner chamber region (245), the inner fluid port (255) and an open mouth region (225) are disposed on the stem axis (140) and optionally are substantially symmetrical along the stem axis (140),

optionally wherein the at least one wall fluid port (270) is oriented along an axis that is substantially perpendicular to the stem axis (140),

optionally wherein the at least one wall fluid port (270) comprises a pair of wall fluid ports arranged at substantially opposite sides of the housing member (220).

7. The apparatus as claimed in claim 2, further comprising:

a first fluid flow path extends from the open region (235), through the at least one fluid communication passageway (290), through the stem housing fluid communication region (149) and into the inner stem channel (176) via the fluid inlet (175), the inner stem channel (176) optionally extending along the stem axis (140).

8. The apparatus as claimed in claim 7, wherein

the first fluid path is operable for fluid flow when the housing member (220) is disposed in a first orientation, wherein the housing member (220) optionally comprises the open region (235) facing in a substantially downward direction,
optionally wherein the apparatus further comprises at least one gas pathway that is at least partly disposed between the housing member (220) and a mounting cup (115) through which the elongate valve stem (135) extends so that, in the first orientation, gas can pass through a gas inlet region (510), into the at least one gas communication region (520), and into a stem gas inlet (179) in the elongate valve stem (135) to mix with fluid in the inner stem channel (176).

9. The apparatus as claimed in claim 2, further comprising:
a further fluid flow path that extends from the fluid communication region located outside of the housing body and the inner chamber region (245) to the inner chamber region (245) via the at least one wall fluid port (270) and, via the inner fluid port (255) from the inner chamber region (245) through the at least one fluid communication passageway (290) and into the inner stem channel (176) via the fluid inlet (175).

10. The apparatus as claimed in claim 9 when dependent on claim 4, wherein
the further fluid path is operable for fluid flow when the housing member (220) is disposed in the further orientation, wherein the housing member (220) optionally comprises the open region (235) facing in a substantially upward direction.

11. The apparatus as claimed in any of claims 7 to 10, wherein

in a first valve stem position the fluid inlet (175) is closed to prevent fluid flow into the inner stem channel (176) to thereby block the first fluid flow path or the further fluid flow path, and in a further valve stem position the fluid inlet (175) is open to permit fluid flow into the inner stem channel (176) to thereby permit fluid flow through the first fluid flow path or the further fluid flow path,
optionally wherein the first valve stem position is an equilibrium position, and the further valve stem position is a position in which the elongate valve stem (135) is urged towards the housing member (220) along the stem axis (140).

12. The apparatus as claimed in claim 11, further comprising:

at least one biasing element (148) that urges the elongate valve stem (135) towards the first valve stem position,
optionally wherein the apparatus further comprises a dip-tube (195) comprising a first end region disposed in the open region (235) and a further end region that is spaced apart from the housing body,
optionally wherein the apparatus further comprises a sloped wall region of the inner wall (250) that is offset from an axis that touches the radially innermost part of the sloped wall region and is parallel with the stem axis (140) so that the sloped wall region makes an angle of 10 degrees or less with the axis,
optionally wherein the housing member comprises an open mouth region (225) at a terminal end of the open region that is at the first end region of the housing member (220), and a neck region that includes a channel disposed between the open mouth region (225) and the main body portion.

13. The apparatus as claimed in any of claims 3 to 12, wherein:

the valve seat region (265) comprises an annular abutment surface for abutting against the closure element (260) that is oblique relative to the stem axis (140) and optionally makes a valve seat angle with the stem axis (140) that is between 30 degrees and 50 degrees,
optionally wherein the valve seat angle is around 45 degrees or around 48 degrees.

14. A fluid dispensing device, comprising:

the apparatus as claimed in any preceding claim; and a canister that is connected to the valve assembly (150) via a/the mounting cup (115) through which the elongate valve stem (135) extends and that comprises at least one fluid to be dispensed and at least one propellant that optionally is a gas.

15. A method for dispensing fluid, comprising the steps of:

providing a fluid at a first end of a fluid communication passageway (290) disposed within a main body portion of a housing member (220) and proximate an open region (235) that is located at a first end region of the housing member (220);
transporting the fluid from the from the first end of the fluid communication passageway (290) to a further end of the fluid communication passageway (290) located at a further end region of the housing member (220) that is spaced apart from the first end region;
transporting the fluid from the further end of the fluid communication passageway end to a stem housing fluid communication region (149) that is located in a stem housing that surrounds at least a portion of a elongate valve stem (135) that is associated with a stem axis (140);
providing at least one gas at a gas communication region (520) that is fluidly connectable to an inner stem channel (176) that extends along at least a portion of the elongate valve stem (135) and is connectable to the stem housing fluid communication region (149); and
transporting the fluid from the first end of the fluid communication passageway (290) to the further end of the fluid communication passageway (290) includes transporting the fluid, via the fluid communication passageway (290), radially outside an inner chamber region (245) that is at least partly surrounded by at least one inner wall (250) of the housing member (220) that is located in the main body portion.

Patentansprüche

1. Vorrichtung zum Abgeben von Fluid, umfassend:

ein Gehäuseglied (220), wobei mindestens eine Innenwand (250) des Gehäuseglieds (220) einen inneren Kammerbereich (245), der in einem Hauptkörperabschnitt des Gehäuseglieds (220) angeordnet ist, mindestens teilweise umgibt, wobei ein innerer Fluidanschluss (255) an einem ersten Endbereich des inneren Kammerbereichs (245) angeordnet ist und mit einem offenen Bereich (235) des Gehäuseglieds (220), der an einem ersten Endbereich des Gehäuseglieds angeordnet ist, in Fluidverbindung steht,
mindestens einen Fluidverbindungsdurchgang (290), der in dem Hauptkörperabschnitt angeordnet ist und ein erstes Ende des mindestens einen Fluidverbindungsdurchgangs in der Nähe des offenen Bereichs (235) und ein verbleibendes Ende des mindestens einen Fluidverbindungsdurchgangs in der Nähe eines weiteren Endes des Gehäuseglieds umfasst, das von dem ersten Endbereich des Gehäuseglieds beabstandet ist, wobei der mindestens eine Fluidverbindungsdurchgang (290) radial außerhalb des inneren Kammerbereichs (245) angeordnet ist und in Fluidverbindung mit dem offenen Bereich (235) steht,
mindestens einen Wandfluidanschluss (270), der sich durch die Innenwand (250) und durch eine Außenfläche des Gehäuseglieds (220) erstreckt, um einen Fluidverbindungsbereich, der außerhalb des Gehäusekörpers angeordnet ist, und den inneren Kammerbereich (245) fluidisch zu verbinden, und
ein Verschlusselement (260), das in dem inneren Kammerbereich (245) angeordnet und darin beweglich ist, um die Fluidströmung durch den inneren Fluidanschluss (255) gezielt zu begrenzen, wobei
das Gehäuseglied (220) mit einer Ventilbaugruppe (150) verbunden oder integral mit dieser ausgebildet ist, die einen länglichen Ventilschaft (135), der einer jeweiligen Schaftachse (140) zugeordnet ist, und ein Schaftgehäuse, das mindestens einen Abschnitt des länglichen Ventilschafts (135) radial umgibt, aufweist, wobei das Schaftgehäuse mindestens einen Schaftgehäusefluidverbindungsbereich (149) umfasst, der mit dem mindestens einen Fluidverbindungsdurchgang (290) in Fluidverbindung steht und mit einem inneren Schaftkanal (176) fluidisch verbindbar ist, der entlang mindestens eines Abschnitts des länglichen Ventilschafts (135) angeordnet ist, wobei das Schaftgehäuse ferner mindestens einen Gasverbindungsbereich (520) umfasst, der fluidisch mit dem inneren Schaftkanal (176) verbindbar ist, so dass mindestens ein Fluid und mindestens ein Gas in dem inneren Schaftkanal (176) mischbar sind.

2. Vorrichtung nach Anspruch **1,** wobei
der längliche Ventilschaft (135) einen Fluideinlass (175) in Fluidverbindung mit dem inneren Schaftkanal (176) und gezielt mit dem Schaftgehäusefluidverbindungsbereich (149) verbindbar sowie einen Schaftgaseinlass (179) in Fluidverbindung mit dem inneren Schaftkanal (176) und gezielt mit dem mindestens einen Gasverbindungsbereich

(520) verbindbar umfasst, wobei der Fluideinlass (175) so angeordnet ist, dass er zur gleichen Zeit mit dem Schaftgehäusefluidverbindungsbereich (149) fluidisch verbunden ist, zu der der Schaftgaseinlass (179) mit dem mindestens einen Gasverbindungsbereich (520) fluidisch verbunden ist, um durch Zweifluidzerstäubung ein feines Spray in dem inneren Schaftkanal (176) bereitzustellen.

3. Vorrichtung nach Anspruch 1 oder Anspruch 2, ferner umfassend:
einen Ventilsitzbereich (265), der in dem inneren Kammerbereich (245) nahe dem inneren Fluidanschluss (255) angeordnet ist, wobei das Verschlusselement (260) gegen den Ventilsitzbereich (265) positionierbar ist, um eine Fluidströmung durch den inneren Fluidanschluss (255) zu verhindern, wenn das Gehäuseglied (220) in einer ersten Ausrichtung angeordnet ist.

4. Vorrichtung nach einem der vorhergehenden Ansprüche, ferner umfassend:
einen Verschlusselementstützbereich (257), der an einem weiteren Endbereich (257) des inneren Kammerbereichs (245) angeordnet ist, der von dem ersten Endbereich des inneren Kammerbereichs (245) beabstandet ist, wobei das Verschlusselement (260) an dem Verschlusselementstützbereich (257) angeordnet werden kann, um eine Fluidströmung durch den inneren Fluidanschluss (255) zu gestatten, wenn das Gehäuseglied (220) in einer weiteren Ausrichtung angeordnet ist, optional wobei das Verschlusselement (260) eine maximale Breite aufweist, die kleiner ist als eine maximale Breite eines Bereichs des inneren Kammerbereichs (245), in dem das Verschlusselement (260) im Betrieb beweglich ist.

5. Vorrichtung nach Anspruch 4, wenn abhängig von Anspruch 3, wobei
das Verschlusselement (260) eine maximale Breite aufweist, die kleiner ist als eine maximale Breite eines Bereichs des inneren Kammerbereichs (245) zwischen dem Ventilsitzbereich (265) und dem Verschlusselementstützbereich (257).

6. Vorrichtung nach einem der vorhergehenden Ansprüche, wobei

das Gehäuseglied (220) an einem weiteren Endbereich des Gehäuseglieds (220), der von dem ersten Endbereich des Gehäuseglieds (220) beabstandet ist, mit der Ventilbaugruppe (150) verbunden ist,
optional wobei der innere Kammerbereich (245), der innere Fluidanschluss (255) und ein offener Mündungsbereich (225) an der Schaftachse (140) angeordnet sind und optional im Wesentlichen symmetrisch entlang der Schaftachse (140) verlaufen,
optional wobei der mindestens eine Wandfluidanschluss (270) entlang einer Achse ausgerichtet ist, die im Wesentlichen senkrecht zu der Schaftachse (140) verläuft, optional wobei der mindestens eine Wandfluidanschluss (270) ein Paar Wandfluidanschlüsse umfasst, die an im Wesentlichen gegenüberliegenden Seiten des Gehäuseglieds (220) angeordnet sind.

7. Vorrichtung nach Anspruch 2, ferner umfassend:
einen ersten Fluidströmungsweg, der sich von dem offenen Bereich (235) über den Fluideinlass (175) durch den mindestens einen Fluidverbindungsdurchgang (290), durch den Schaftgehäusefluidverbindungsbereich (149) und in den inneren Schaftkanal (176) erstreckt, wobei sich der innere Schaftkanal (176) optional entlang der Schaftachse (140) erstreckt.

8. Vorrichtung nach Anspruch 7, wobei

der erste Fluidweg für eine Fluidströmung betreibbar ist, wenn das Gehäuseglied (220) in einer ersten Ausrichtung angeordnet ist, wobei das Gehäuseglied (220) optional den offenen Bereich (235) umfasst, der in eine im Wesentlichen nach unten gerichtete Richtung weist,
optional wobei die Vorrichtung ferner mindestens einen Gasweg umfasst, der mindestens teilweise zwischen dem Gehäuseglied (220) und einem Montagebecher (115) angeordnet ist, durch den sich der längliche Ventilschaft (135) erstreckt, so dass Gas in der ersten Ausrichtung durch einen Gaseinlassbereich (510) in den mindestens einen Gasverbindungsbereich (520) und in einen Schaftgaseinlass (179) in dem länglichen Ventilschaft (135) gehen kann, um sich mit Fluid in dem inneren Schaftkanal (176) zu vermischen.

9. Vorrichtung nach Anspruch 2, ferner umfassend:
einen weiteren Fluidströmungsweg, der sich von dem Fluidverbindungsbereich, das sich außerhalb des Gehäusekörpers und des inneren Kammerbereichs (245) befindet, über den mindestens einen Wandfluidanschluss (270) zu dem innere Kammerbereich (245) und über den inneren Fluidanschluss (255) von dem inneren Kammer-

bereich (245) durch den mindestens einen Fluidverbindungsdurchgang (290) und in den inneren Schaftkanal (176) über den Fluideinlass (175) erstreckt.

10. Vorrichtung nach Anspruch 9, wenn abhängig von Anspruch 4, wobei der weitere Fluidweg für eine Fluidströmung betreibbar ist, wenn das Gehäuseglied (220) in der weiteren Ausrichtung angeordnet ist, wobei das Gehäuseglied (220) optional den offenen Bereich (235) umfasst, der in eine im Wesentlichen nach oben gerichtete Richtung weist.

11. Vorrichtung nach einem der Ansprüche 7 bis 10, wobei

der Fluideinlass (175) in einer ersten Ventilschaftposition geschlossen ist, um eine Fluidströmung in den inneren Schaftkanal (176) zu verhindern, um dadurch den ersten Fluidströmungsweg oder den weiteren Fluidströmungsweg zu blockieren, und der Fluideinlass (175) in einer weiteren Ventilschaftposition offen ist, um eine Fluidströmung in den inneren Schaftkanal (176) zu gestatten, um dadurch eine Fluidströmung durch den ersten Fluidströmungsweg oder den weiteren Fluidströmungsweg zu gestatten,
optional wobei die erste Ventilschaftposition eine Gleichgewichtsposition ist und die weitere Ventilschaftposition eine Position ist, in der der längliche Ventilschaft (135) entlang der Schaftachse (140) zu dem Gehäuseglied (220) hin gedrückt wird.

12. Vorrichtung nach Anspruch 11, ferner umfassend:

mindestens ein Vorspannelement (148), das den länglichen Ventilschaft (135) zu der ersten Ventilschaftposition hin drängt,
optional wobei die Vorrichtung ferner ein Tauchrohr (195) umfasst, das einen ersten Endbereich, der in dem offenen Bereich (235) angeordnet ist, und einen weiteren Endbereich, der von dem Gehäusekörper beabstandet ist, umfasst,
optional wobei die Vorrichtung ferner einen geneigten Wandbereich der Innenwand (250) umfasst, der von einer Achse versetzt ist, die den radial innersten Teil des geneigten Wandbereichs berührt und parallel zu der Schaftachse (140) verläuft, so dass der geneigte Wandbereich einen Winkel von 10 Grad oder weniger zu der Achse einnimmt,
optional wobei das Gehäuseglied einen offenen Mündungsbereich (225) an einem Abschlussende des offenen Bereichs, der sich an dem ersten Endbereich des Gehäuseglieds (220) befindet, und einen Halsbereich, der einen Kanal aufweist, der zwischen dem offenen Mündungsbereich (225) und dem Hauptkörperabschnitt angeordnet ist, umfasst.

13. Vorrichtung nach einem der Ansprüche 3 bis 12, wobei:

der Ventilsitzbereich (265) eine ringförmige Anlagefläche zur Anlage an dem Verschlusselement (260) umfasst, die schräg zu der Schaftachse (140) verläuft und optional einen Ventilsitzwinkel zu der Schaftachse (140) einnimmt, der zwischen 30 Grad und 50 Grad beträgt,
optional wobei der Ventilsitzwinkel etwa 45 Grad oder etwa 48 Grad beträgt.

14. Fluidabgabevorrichtung, umfassend:

die Vorrichtung nach einem der vorhergehenden Ansprüche und
einen Kanister, der über einen/den Montagebecher (115), durch den sich der längliche Ventilschaft (135) erstreckt, mit der Ventilbaugruppe (150) verbunden ist und der mindestens ein abzugebendes Fluid und mindestens ein Treibmittel, das gegebenenfalls ein Gas ist, umfasst.

15. Verfahren zum Abgeben von Fluid, umfassend die folgenden Schritte:

Bereitstellen eines Fluids an einem ersten Ende eines Fluidverbindungsdurchgangs (290), der in einem Hauptkörperabschnitt eines Gehäuseglieds (220) und in der Nähe eines offenen Bereichs (235) angeordnet ist, der an einem ersten Endbereich des Gehäuseglieds (220) angeordnet ist,
Transportieren des Fluids von dem ersten Ende des Fluidverbindungsdurchgangs (290) zu einem weiteren Ende des Fluidverbindungsdurchgangs (290), das sich an einem weiteren Endbereich des Gehäuseglieds (220) befindet, der von dem ersten Endbereich beabstandet ist,
Transportieren des Fluids von dem weiteren Ende des Fluidverbindungsdurchgangsendes zu einem Schaft-

gehäusefluidverbindungsbereich (149), der in einem Schaftgehäuse angeordnet ist, das mindestens einen Abschnitt eines länglichen Ventilschafts (135) umgibt, der einer Schaftachse (140) zugeordnet ist,
Bereitstellen mindestens eines Gases an einem Gasverbindungsbereich (520), der fluidisch mit einem inneren Schaftkanal (176) verbindbar ist, der sich entlang mindestens eines Abschnitts des länglichen Ventilschafts (135) erstreckt und mit dem Schaftgehäusefluidverbindungsbereich (149) verbindbar ist, und
wobei das Transportieren des Fluids von dem ersten Ende des Fluidverbindungsdurchgangs (290) zu dem weiteren Ende des Fluidverbindungsdurchgangs (290) das Transportieren des Fluids über den Fluidverbindungsdurchgang (290) radial außerhalb eines inneren Kammerbereichs (245) beinhaltet, der mindestens teilweise von mindestens einer Innenwand (250) des Gehäuseglieds (220) umgeben ist, das in dem Hauptkörperabschnitt angeordnet ist.

Revendications

1. Appareil de distribution de fluide comprenant :

un élément logement (220), au moins une paroi interne (250) de l'élément logement (220) entourant au moins partiellement une région de chambre interne (245) qui est disposée à l'intérieur d'une partie de corps principal de l'élément logement (220), un orifice de fluide interne (255) étant disposé au niveau d'une première région d'extrémité de la région de chambre interne (245) et en communication fluidique avec une région ouverte (235) de l'élément logement (220) disposée au niveau d'une première région d'extrémité de l'élément logement ;
au moins un passage de communication fluidique (290) disposé à l'intérieur de la partie de corps principal et comprenant une première extrémité de l'au moins un passage de communication fluidique proche de la région ouverte (235), et une extrémité restante de l'au moins un passage de communication fluidique, proche d'une autre extrémité de l'élément logement, qui est espacée de la première région d'extrémité de l'élément logement, l'au moins un passage de communication fluidique (290) étant disposé radialement à l'extérieur de la région de chambre interne (245) et étant en communication fluidique avec la région ouverte (235) ;
au moins un orifice de fluide de paroi (270) s'étendant à travers la paroi interne (250) et à travers une surface externe de l'élément logement (220) pour relier fluidiquement une région de communication fluidique située à l'extérieur du corps de logement et la région de chambre interne (245) ; et
un élément de fermeture (260) disposé dans la région de chambre interne (245) et mobile à l'intérieur de celle-ci pour limiter sélectivement l'écoulement de fluide à travers l'orifice de fluide interne (255) ;
l'élément logement (220) étant relié **à,** ou étant formé **d'un** seul tenant avec, un ensemble soupape (150) qui comprend une tige de soupape allongée (135) associée à un axe de tige (140) respectif et un logement de tige qui entoure radialement au moins une partie de la tige de soupape allongée (135), le logement de tige comprenant au moins une région de communication fluidique de logement de tige (149) qui est en communication fluidique avec au moins un passage de communication fluidique (290) et qui peut être en communication fluidique avec un canal de tige interne (176) situé le long d'au moins une partie de la tige de soupape allongée (135), le logement de tige comprenant en outre au moins une région de communication de gaz (520) qui peut être en communication fluidique avec le canal de tige interne (176) de sorte qu'au moins un fluide et au moins un gaz puissent être mélangés dans le canal de tige interne (176).

2. Appareil selon la revendication 1,
la tige de soupape allongée (135) comprenant une entrée de fluide (175) en communication fluidique avec le canal de tige interne (176) et pouvant être reliée sélectivement avec la région de communication fluidique de logement de tige (149), et une entrée de gaz de tige (179) en communication fluidique avec le canal de tige interne (176) et pouvant être reliée sélectivement avec l'au moins une région de communication de gaz (520), l'entrée de fluide (175) étant disposée de sorte à être reliée en communication fluidique avec la région de communication fluidique de logement de tige (149) en même temps que l'entrée de gaz de tige (179) est reliée en communication fluidique avec l'au moins une région de communication de gaz (520) afin de fournir une pulvérisation fine dans le canal de tige interne (176) par atomisation de deux fluides.

3. Appareil selon la revendication 1 ou 2, comprenant en outre :
une région de siège de soupape (265) située dans la région de chambre interne (245) à proximité de l'orifice de fluide interne (255), l'élément de fermeture (260) pouvant être placé contre la région de siège de soupape (265) pour empêcher l'écoulement de fluide à travers l'orifice de fluide interne (255) lorsque l'élément logement (220) est disposé dans une première orientation.

4. Appareil selon l'une quelconque des revendications précédentes, comprenant en outre :
une région de support d'élément de fermeture (257) disposée au niveau d'une autre région d'extrémité (257) de la région de chambre interne (245) qui est espacée de la première région d'extrémité de la région de chambre interne (245), l'élément de fermeture (260) pouvant être placé contre la région de support d'élément de fermeture (257) pour permettre l'écoulement de fluide à travers l'orifice de fluide interne (255) lorsque l'élément logement (220) est disposé dans une autre orientation, éventuellement, l'élément de fermeture (260) ayant une largeur maximale qui est inférieure à la largeur maximale d'une région de la chambre intérieure (245) dans laquelle l'élément de fermeture (260) est mobile en fonctionnement.

5. Appareil selon la revendication 4 lorsqu'elle dépend de la revendication 3,
l'élément de fermeture (260) ayant une largeur maximum qui est inférieure à la largeur maximum d'une région de la région de chambre interne (245) entre la région de siège de soupape (265) et la région de support d'élément de fermeture (257).

6. Appareil selon l'une quelconque des revendications précédentes,

l'élément logement (220) étant relié à l'ensemble soupape (150) au niveau d'une autre extrémité de l'élément logement (220) qui est espacée de la première région d'extrémité de l'élément logement (220),
éventuellement, la région de chambre interne (245), l'orifice de fluide interne (255) et une région d'embouchure ouverte (225) étant situés sur l'axe de tige (140) et, éventuellement, étant sensiblement symétriques le long de l'axe de tige (140),
éventuellement, l'au moins un orifice de fluide de paroi (270) étant orienté le long d'un axe qui est sensiblement perpendiculaire à l'axe de tige (140),
éventuellement, l'au moins un orifice de fluide de paroi (270) comprenant une paire d'orifices de fluide de paroi situés sur des côtés sensiblement opposés de l'élément logement (220).

7. Appareil selon la revendication 2, comprenant en outre :
un premier chemin d'écoulement de fluide s'étendant de la région ouverte (235), à travers l'au moins un passage de communication fluidique (290), à travers la région de communication fluidique de logement de tige (149) et dans le canal de tige interne (176) par l'intermédiaire de l'entrée de fluide (175), le canal de tige interne (176) s'étendant éventuellement le long de l'axe de tige (140).

8. Appareil selon la revendication **7,**

le premier chemin de fluide étant utilisable pour l'écoulement de fluide lorsque l'élément logement (220) est disposé dans une première orientation, l'élément logement (220) comprenant éventuellement la région ouverte (235) orientée dans une direction sensiblement vers le bas,
éventuellement, l'appareil comprenant en outre au moins un passage de gaz qui est au moins partiellement disposé entre l'élément logement (220) et une coupelle de montage (115) à travers laquelle la tige de soupape allongée (135) s'étend de sorte que, dans la première orientation, le gaz puisse passer à travers une région d'entrée de gaz (510), dans l'au moins une région de communication de gaz (520), et dans une entrée de gaz de tige (179) dans la tige de soupape allongée (135) pour se mélanger au fluide dans le canal de tige intérieur (176).

9. Appareil selon la revendication 2, comprenant en outre :
un autre chemin d'écoulement de fluide qui s'étend de la région de communication fluidique située à l'extérieur du corps de logement et de la région de chambre interne (245) à la région de chambre interne (245) par l'intermédiaire de l'au moins un orifice de fluide de paroi (270) et, par l'intermédiaire de l'orifice de fluide interne (255), de la région de chambre interne (245) à travers l'au moins un passage de communication fluidique (290) et dans le canal de tige intérieur (176) par l'intermédiaire de l'entrée de fluide (175).

10. Appareil selon la revendication 9 lorsqu'elle dépend de la revendication 4,
l'autre chemin de fluide étant utilisable pour l'écoulement de fluide lorsque l'élément logement (220) est disposé dans l'autre orientation, l'élément logement (220) comprenant éventuellement la région ouverte (235) orientée dans une direction sensiblement vers le haut.

11. Appareil selon l'une quelconque des revendications 7 à 10,

dans une première position de tige de soupape, l'entrée de fluide (175) étant fermée pour empêcher l'écoulement de fluide dans le canal de tige interne (176) pour ainsi bloquer le premier chemin d'écoulement de fluide ou l'autre chemin d'écoulement de fluide, et dans une autre position de tige de soupape, l'entrée de fluide (175) étant ouverte pour permettre l'écoulement de fluide dans le canal de tige interne (176) pour ainsi permettre l'écoulement de fluide à travers le premier chemin d'écoulement de fluide ou l'autre chemin d'écoulement de fluide, éventuellement, la première position de tige de soupape étant une position d'équilibre, et l'autre position de tige de soupape étant une position dans laquelle la tige de soupape allongée (135) est poussée vers l'élément logement (220) le long de l'axe de tige (140).

12. Appareil selon la revendication 11, comprenant en outre :

au moins un élément de sollicitation (148) qui pousse la tige de soupape allongée (135) vers la première position de tige de soupape,
éventuellement, l'appareil comprenant en outre un tube plongeur (195) comprenant une première région d'extrémité disposée dans la région ouverte (235) et une autre région d'extrémité qui est espacée du corps de logement, éventuellement, l'appareil comprenant en outre une région de paroi inclinée de la paroi interne (250) qui est décalée par rapport à un axe qui touche la partie la plus radialement intérieure de la région de paroi inclinée et qui est parallèle à l'axe de tige (140), de sorte que la région de paroi inclinée forme un angle de 10 degrés ou moins avec l'axe,
éventuellement, l'élément logement comprenant une région d'embouchure ouverte (225) au niveau d'une extrémité terminale de la région ouverte qui se trouve au niveau de la première région d'extrémité de l'élément logement (220), et une région de col qui comprend un canal disposé entre la région d'embouchure ouverte (225) et la partie de corps principal.

13. Appareil selon l'une quelconque des revendications 3 à 12,

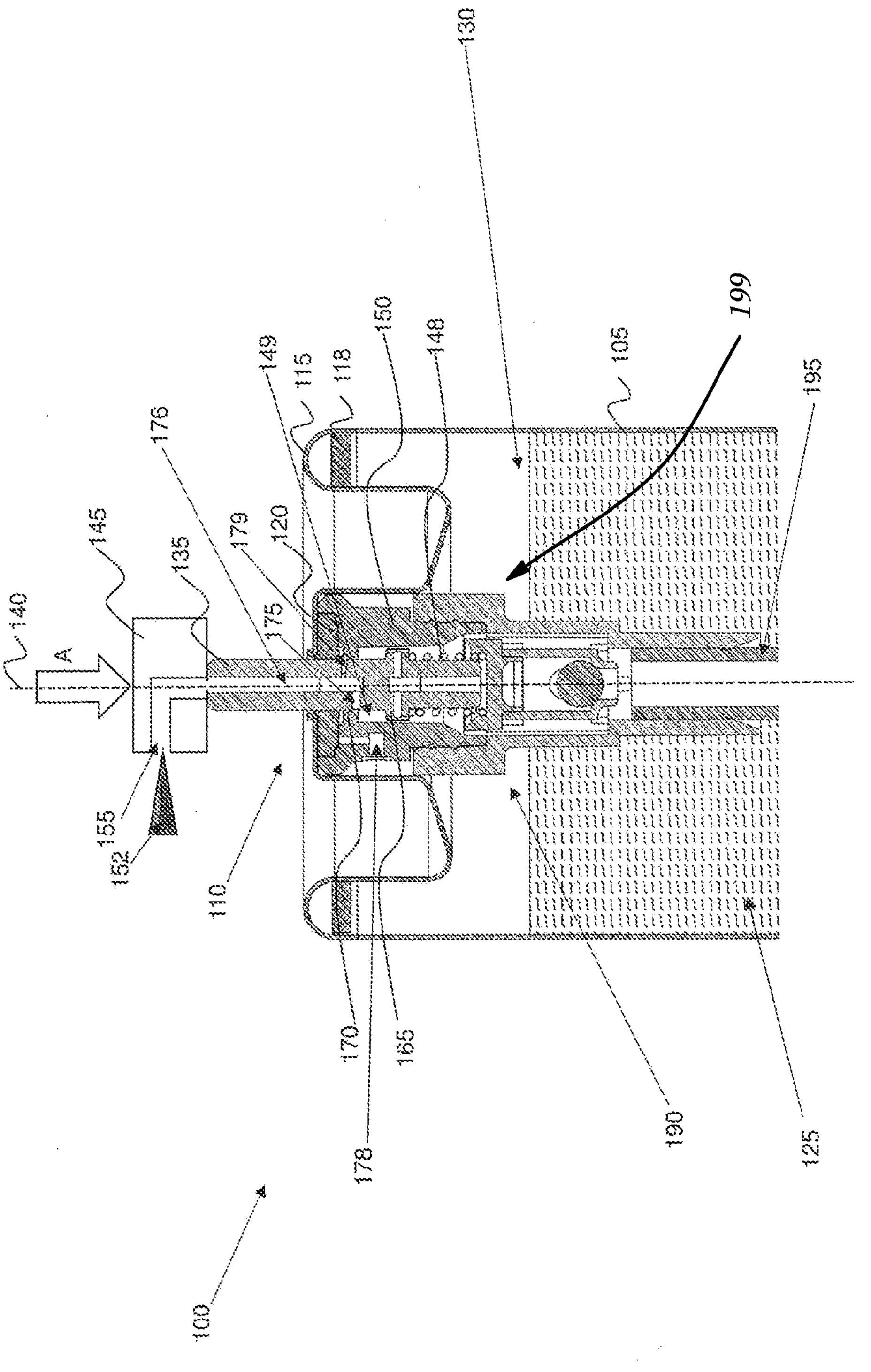
la région de siège de soupape (265) comprenant une surface d'appui annulaire pour venir en butée contre l'élément de fermeture (260) qui est oblique par rapport à l'axe de tige (140) et qui fait éventuellement un angle de siège de soupape avec l'axe de tige (140) qui est compris entre 30 degrés et 50 degrés,
éventuellement l'angle de siège de soupape étant d'environ 45 degrés ou d'environ 48 degrés.

14. Dispositif de distribution de fluide, comprenant :

l'appareil selon l'une quelconque des revendications précédentes ; et
un bidon qui est relié à l'ensemble soupape (150) par l'intermédiaire d'une/de la coupelle de montage (115) à travers laquelle s'étend la tige de soupape allongée (135) et qui comprend au moins un fluide à distribuer et au moins un agent propulseur qui est éventuellement un gaz.

15. Procédé de distribution de fluide, comprenant :

la fourniture d'un fluide au niveau d'une première extrémité d'un passage de communication fluidique (290) disposé à l'intérieur d'une partie de corps principal d'un élément logement (220) et à proximité d'une région ouverte (235) qui est située au niveau d'une première région d'extrémité de l'élément logement (220) ;
le transport du fluide de la première extrémité du passage de communication fluidique (290) à une autre extrémité du passage de communication fluidique (290) située au niveau d'une autre région d'extrémité de l'élément logement (220) qui est espacée de la première région extrémité ;
le transport du fluide de l'autre extrémité du passage de communication fluidique vers une région de communication fluidique de logement de tige (149) qui est située dans un logement de tige qui entoure au moins une partie d'une tige de soupape allongée (135) qui est associée à un axe de tige (140) ;
la fourniture d'au moins un gaz au niveau d'une région de communication de gaz (520) qui est en communication fluidique avec un canal de tige interne (176) qui s'étend le long d'au moins une partie de la tige de soupape allongée (135) et qui peut être reliée à la région de communication fluidique de logement de tige (149) ; et
le transport du fluide de la première extrémité du passage de communication fluidique (290) à l'autre extrémité du passage de communication fluidique (290) comprenant le transport du fluide, par l'intermédiaire du passage de communication fluidique (290), radialement à l'extérieur d'une région de chambre interne (245) qui est au moins partiellement entourée par au moins une paroi interne (250) de l'élément logement (220) qui est situé dans la partie de corps principal.


140
A
145
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179
120
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130
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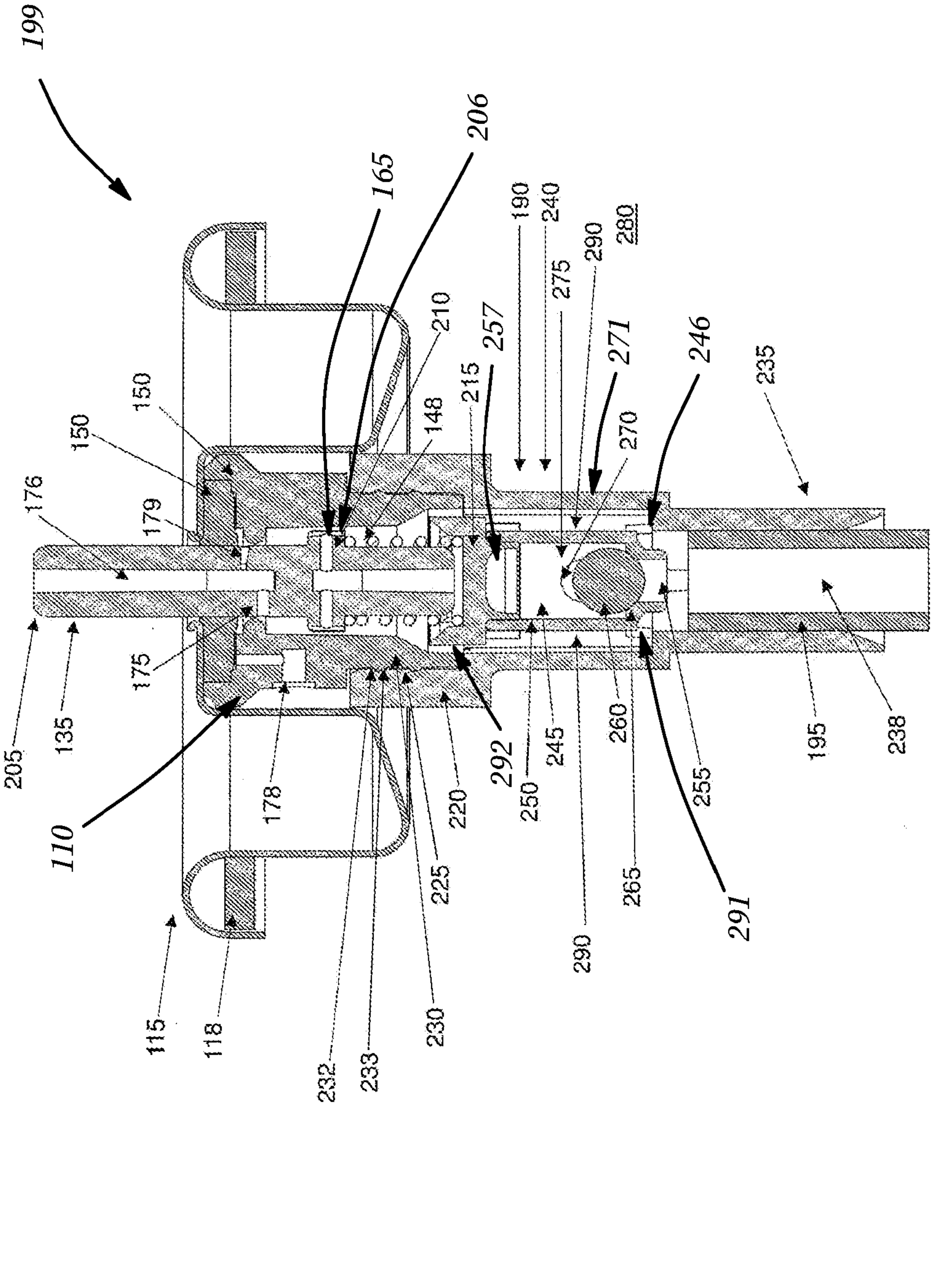
178
190
125
100

Figure 1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206
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175
205
135
110
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260
255
265
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238
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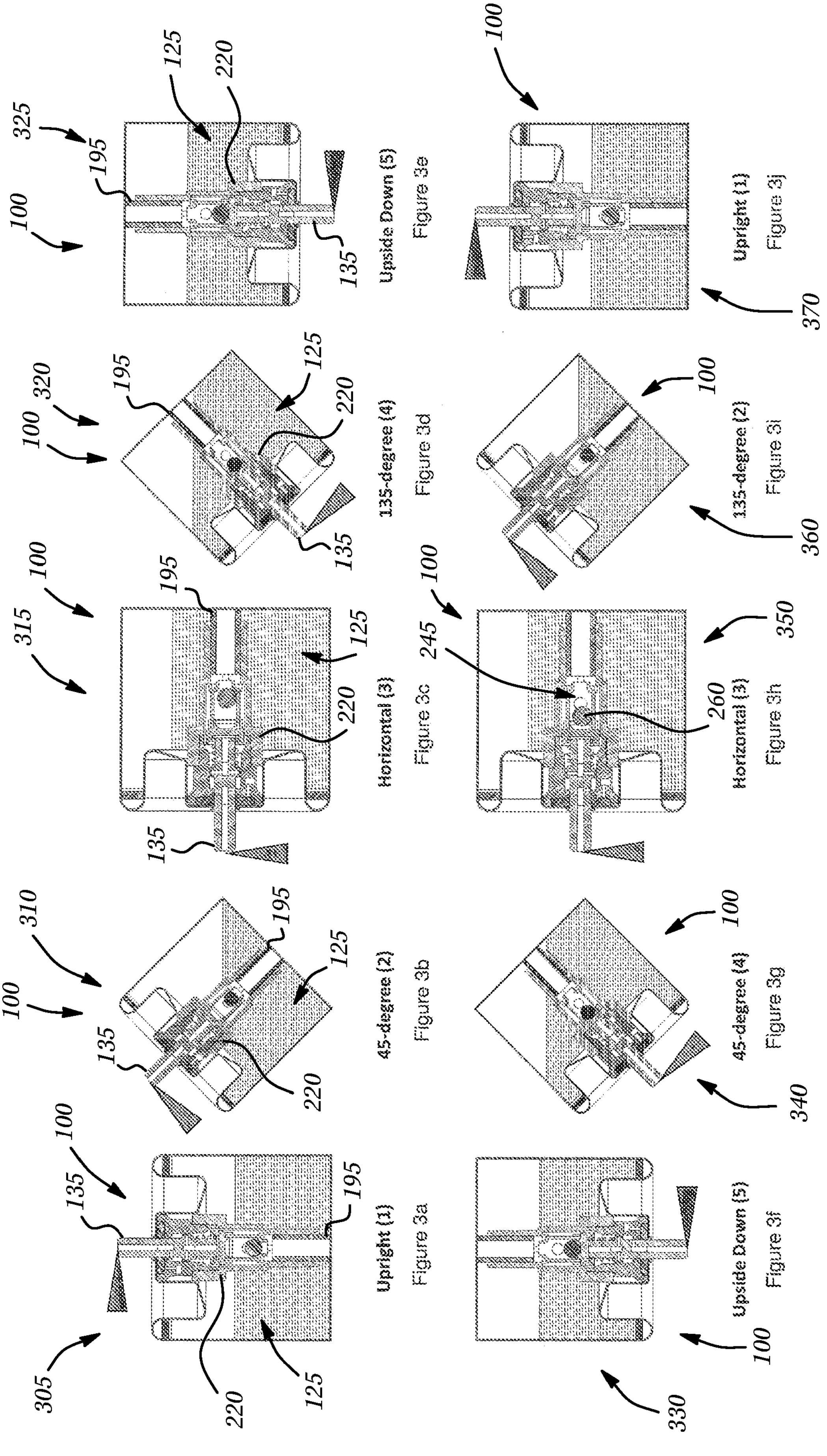
232
233
230
225

Figure 2



Upright (1) Figure 3a

45-degree (2) Figure 3b

Horizontal (3) Figure 3c

135-degree (4) Figure 3d

Upside Down (5) Figure 3e

Upside Down (5) Figure 3f

45-degree (4) Figure 3g

Horizontal (3) Figure 3h

135-degree (2) Figure 3i

Upright (1) Figure 3j

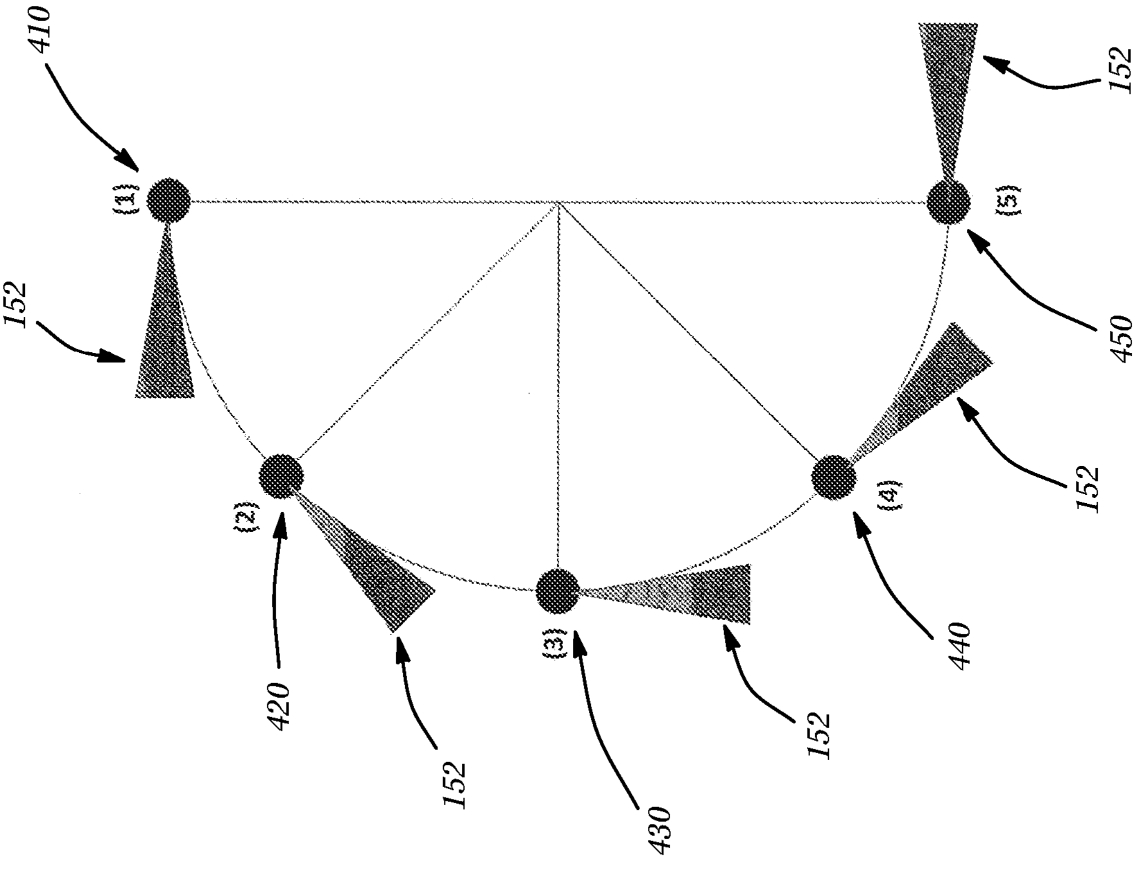


Figure 4

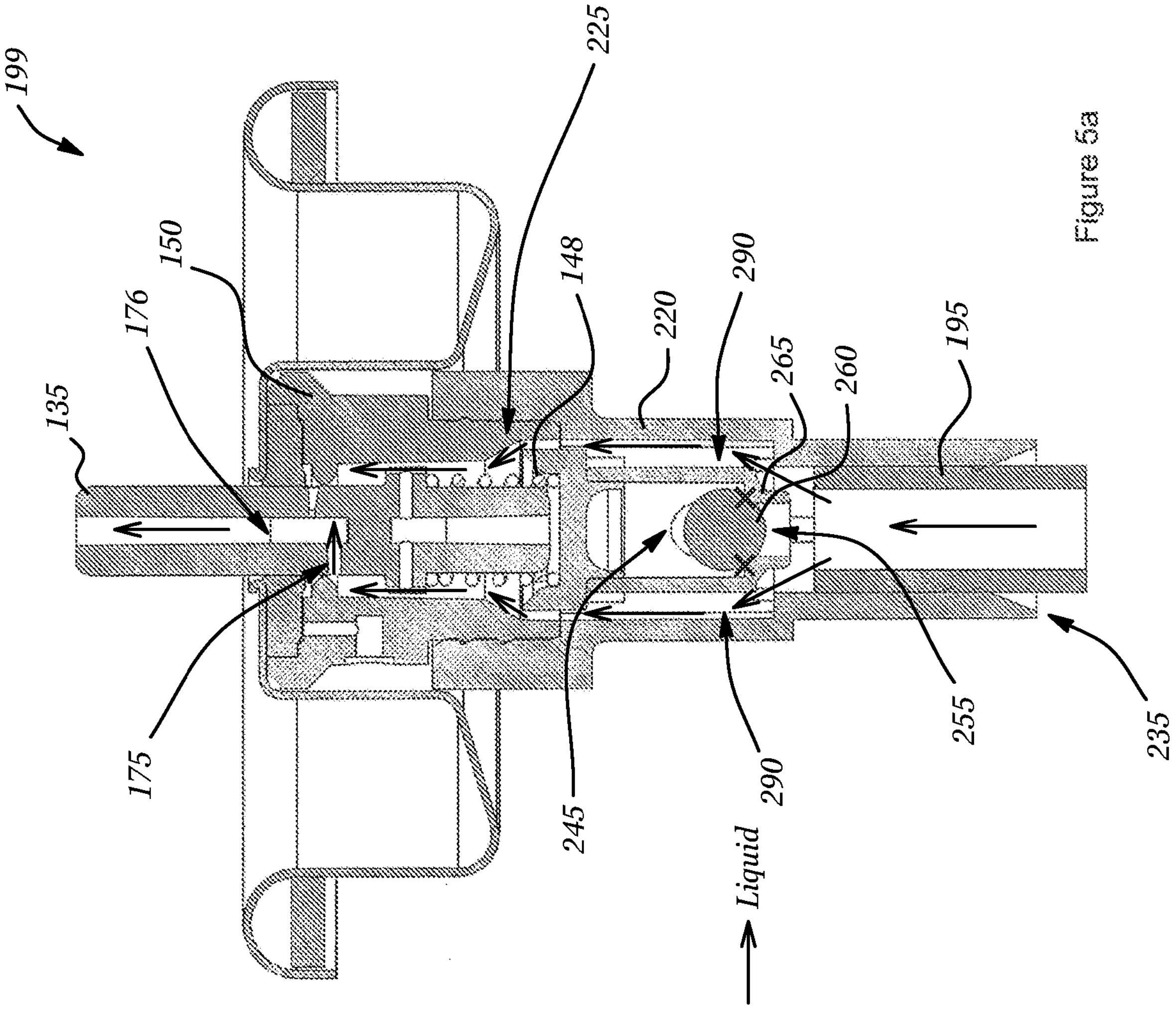
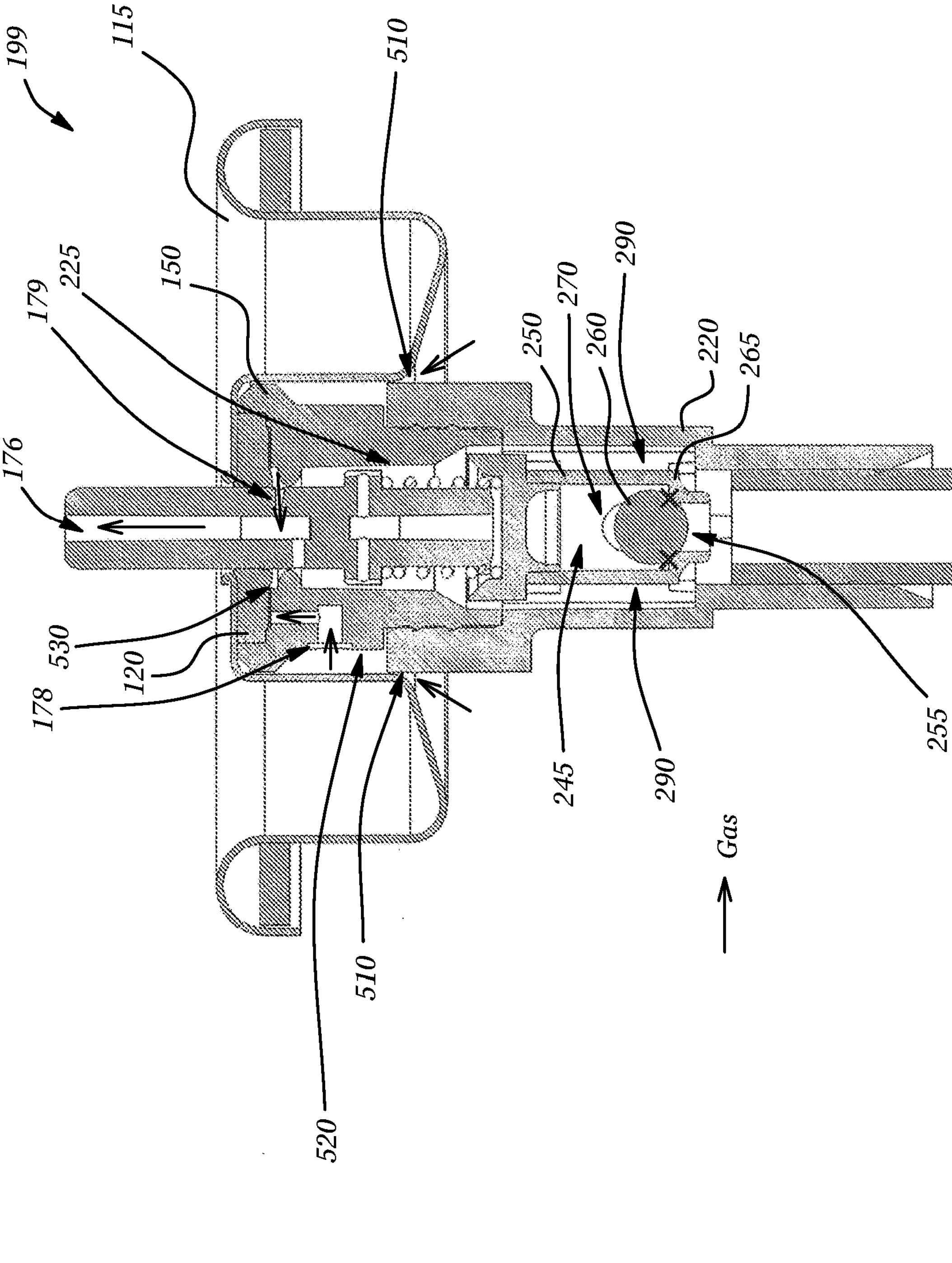

199
135
176
150
225
148
220
290
265
260
195
175
245
290
255
235
Liquid

Figure 5a


199
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260
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265
245
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255
Gas

Figure 5b

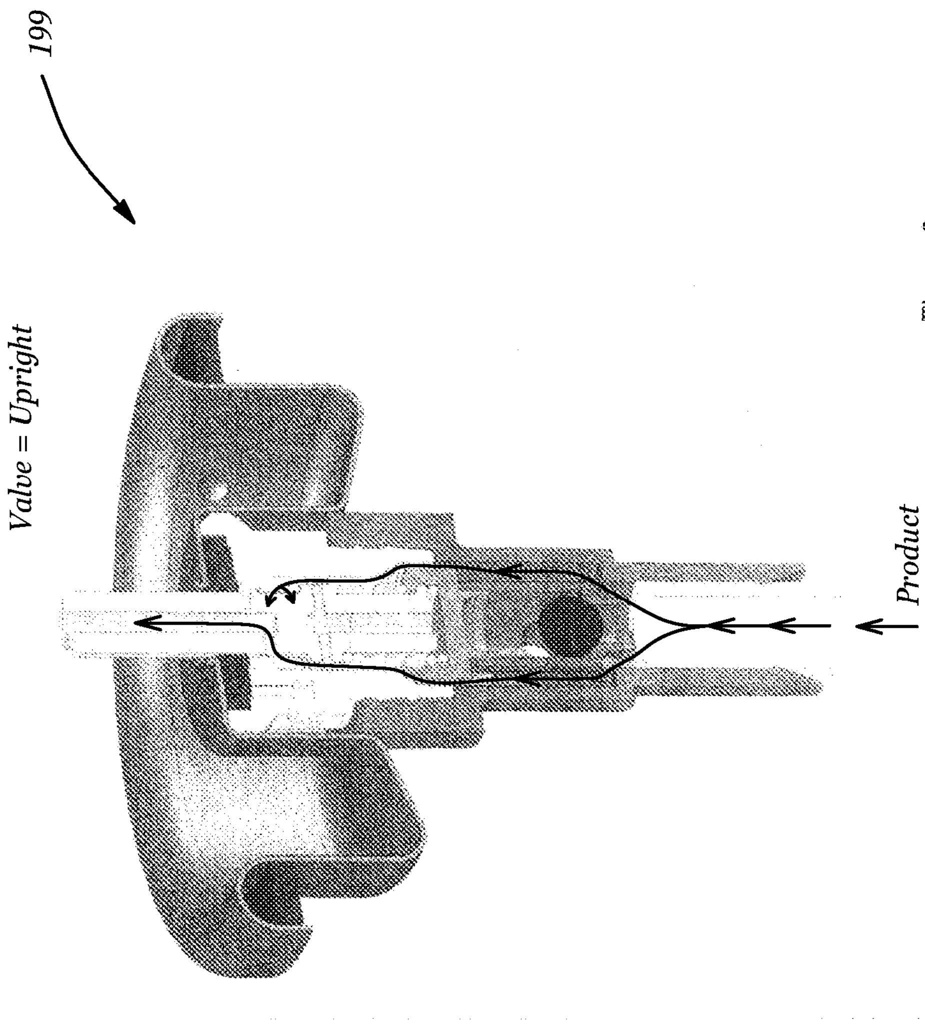


Figure 6

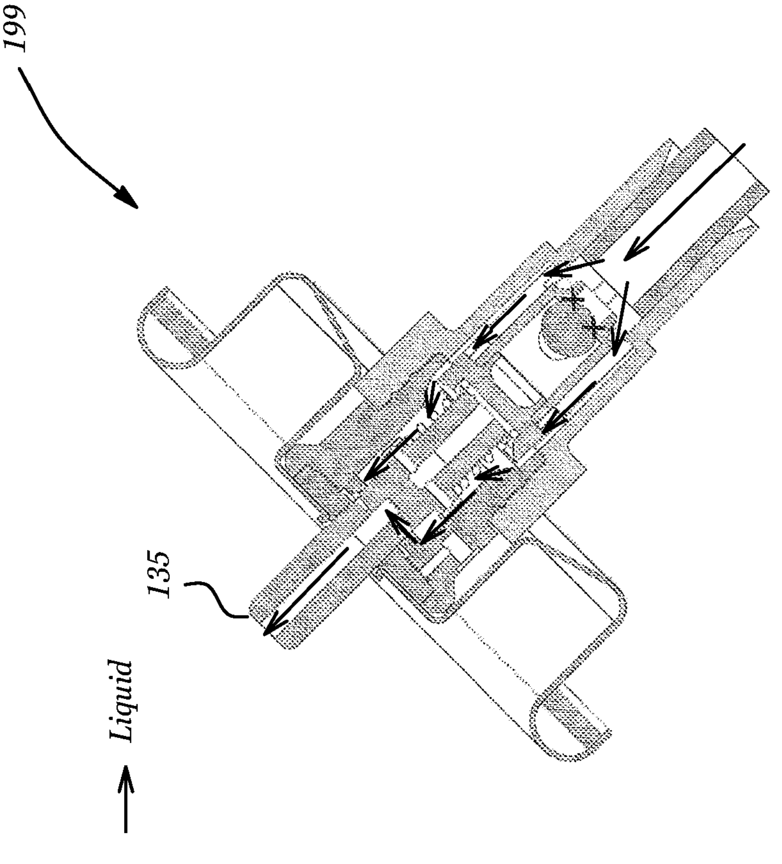


Figure 7a

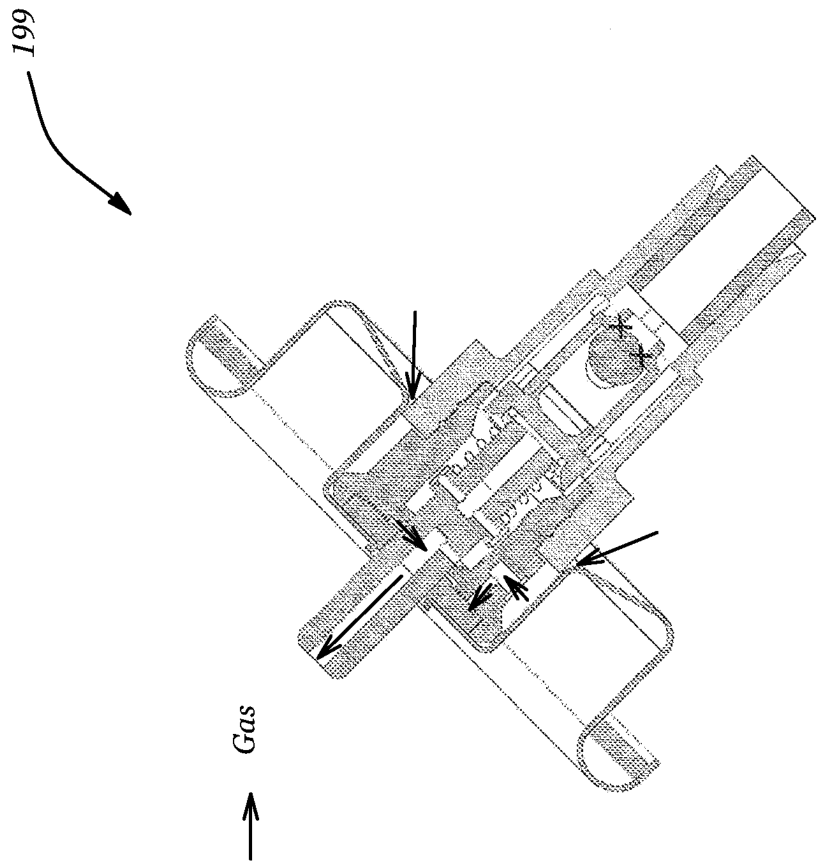


Figure 7b

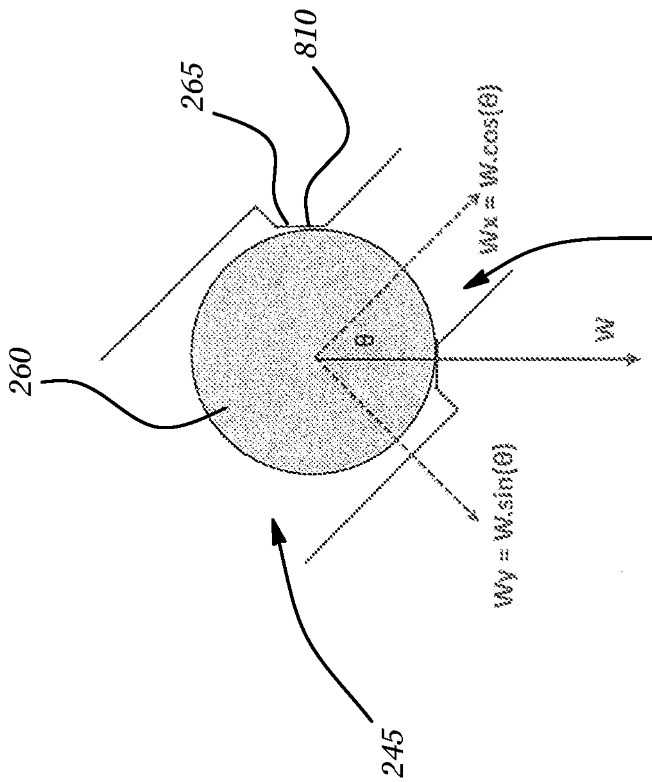


Figure 8

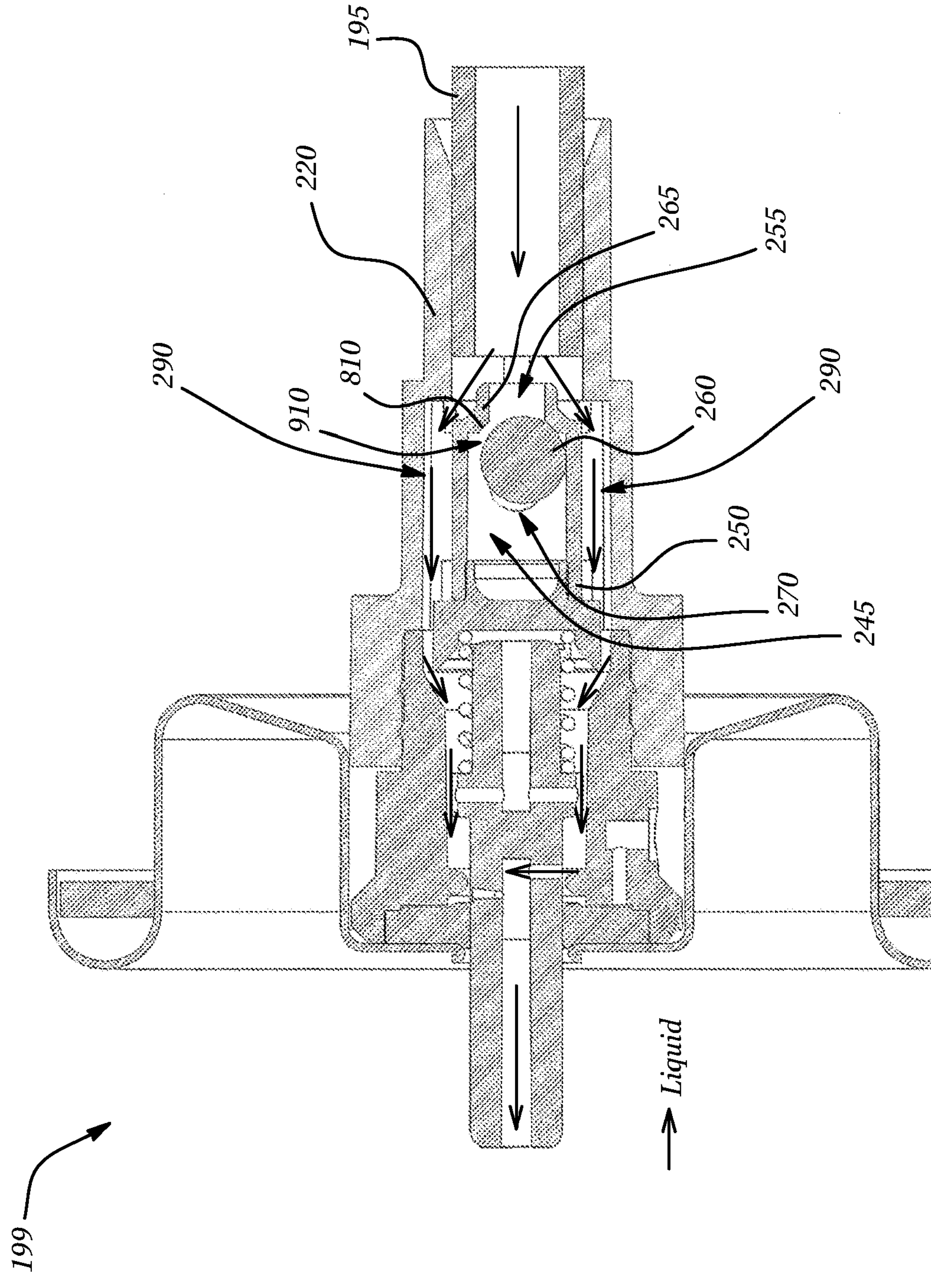


Figure 9a

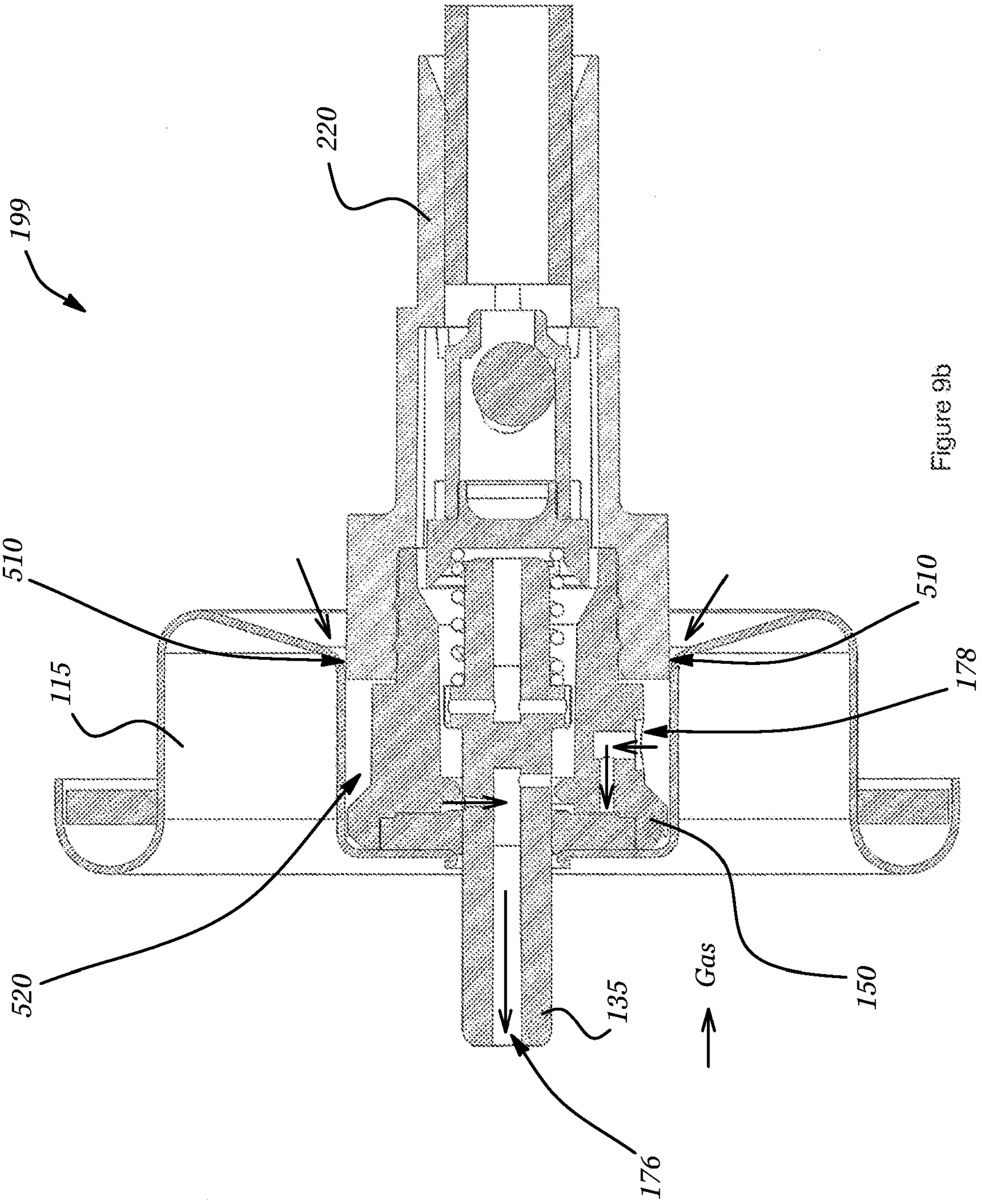
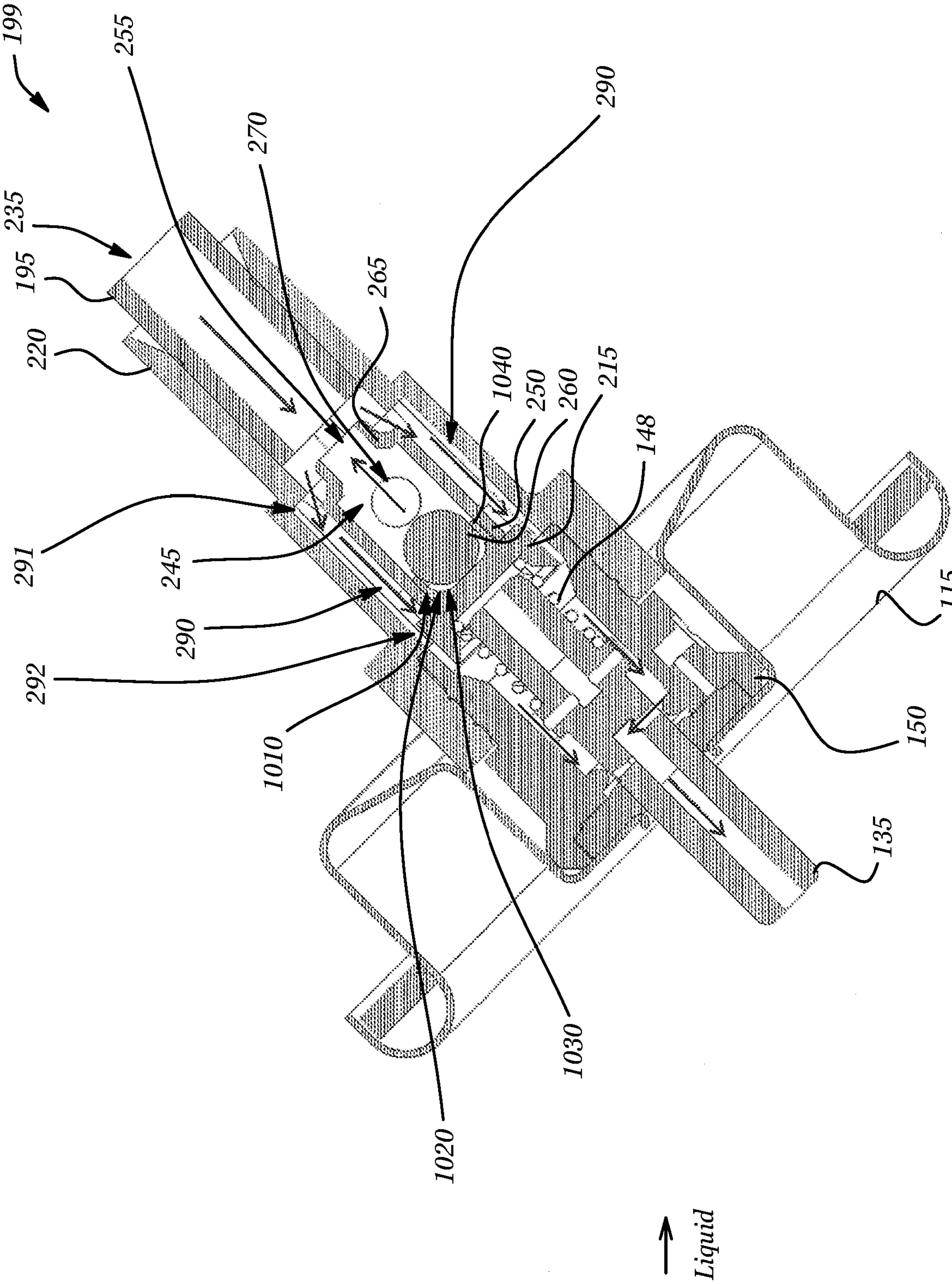


Figure 9b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135
1030
1020
Liquid

Figure 10a

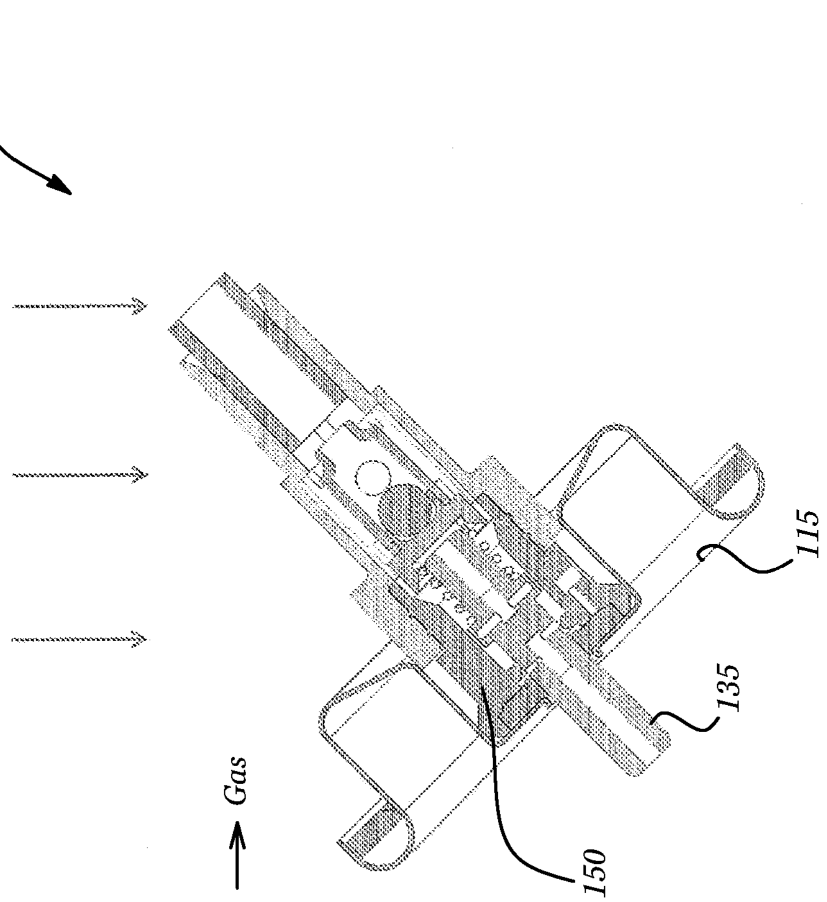


Figure 10b

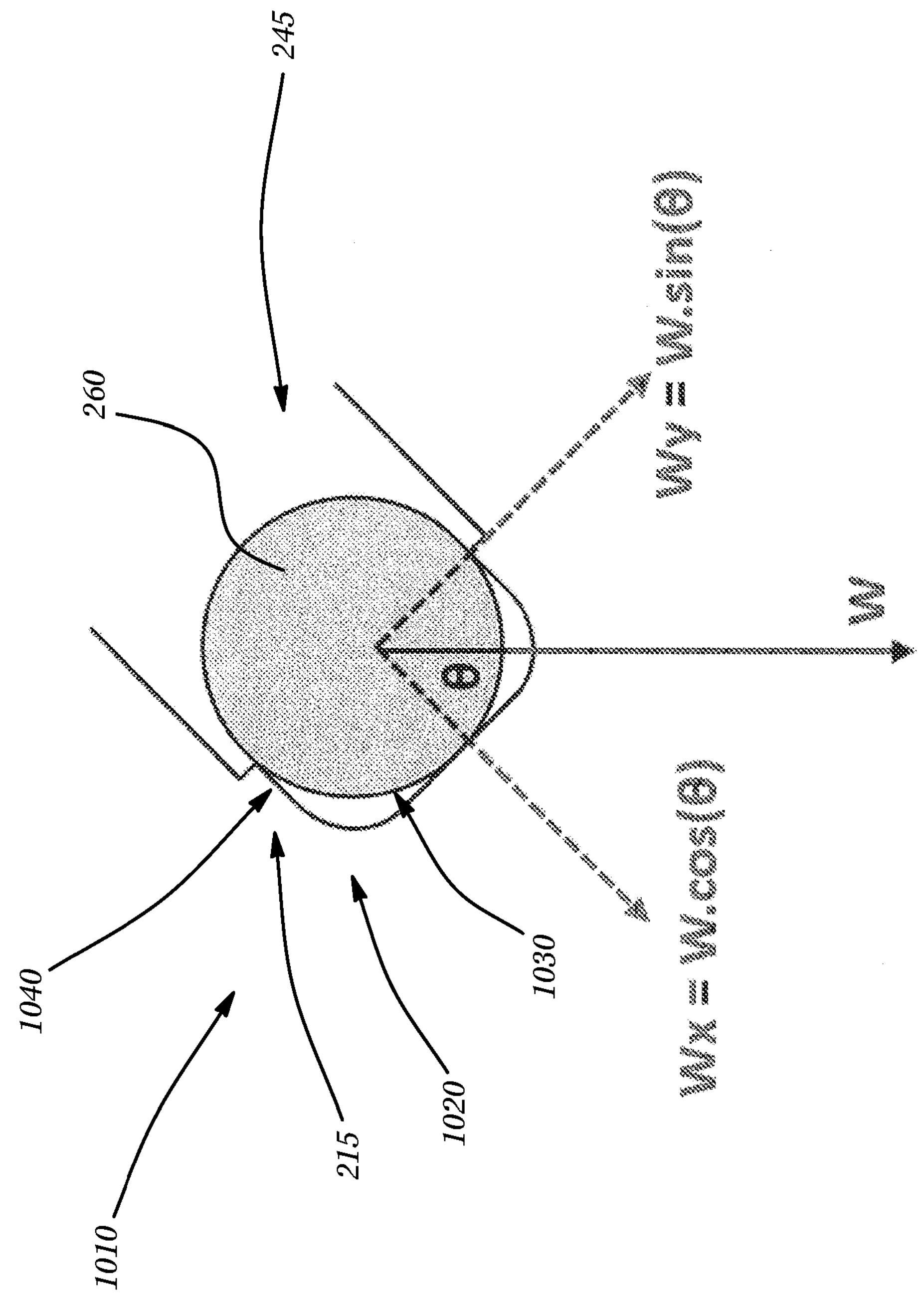


Figure 11

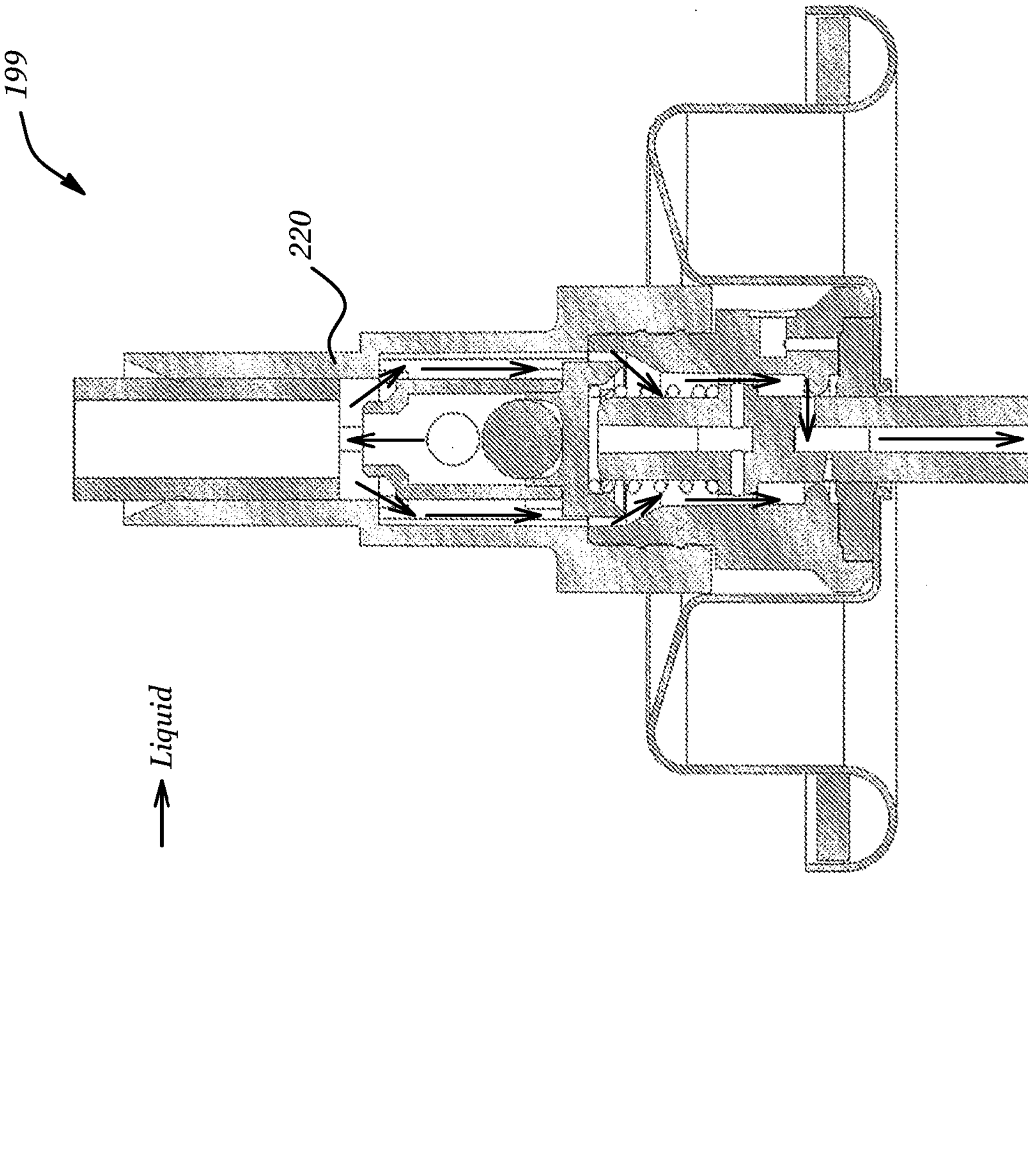


Figure 12a

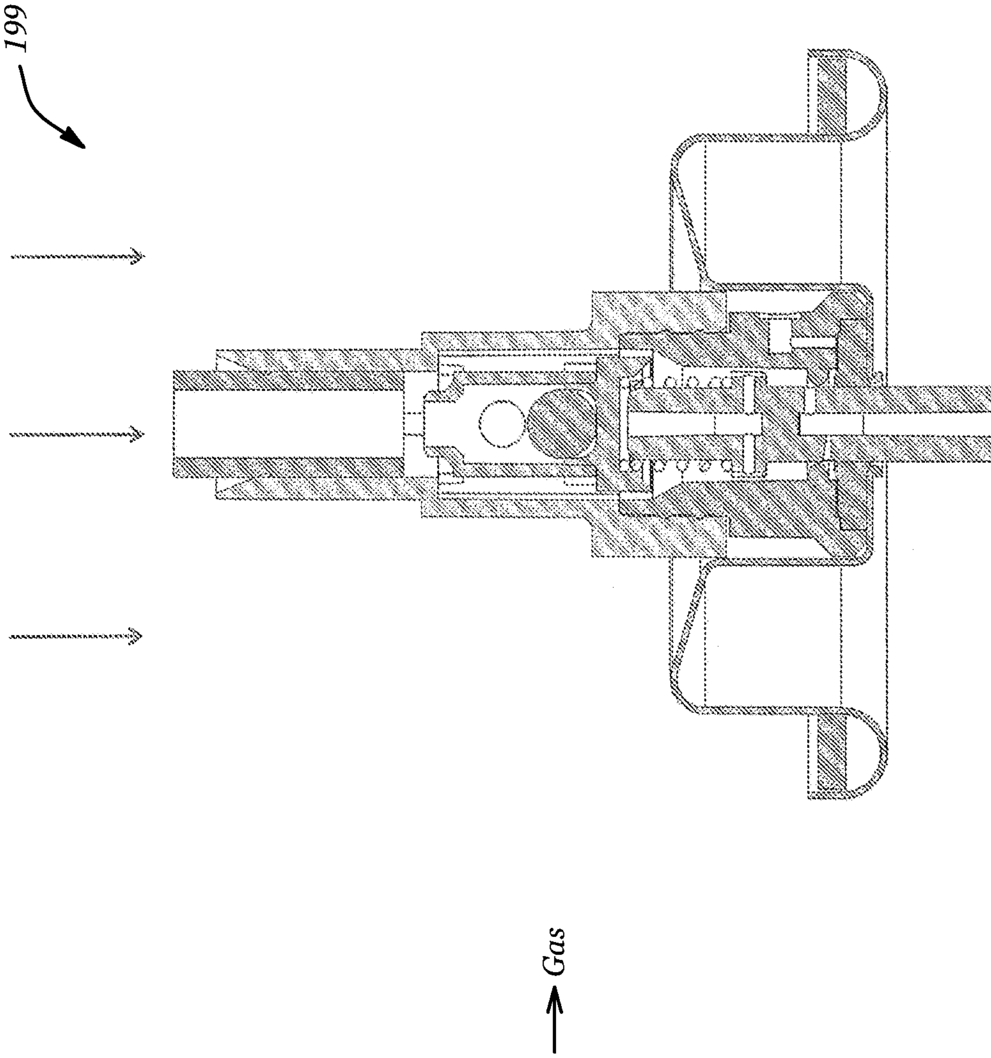


Figure 12b

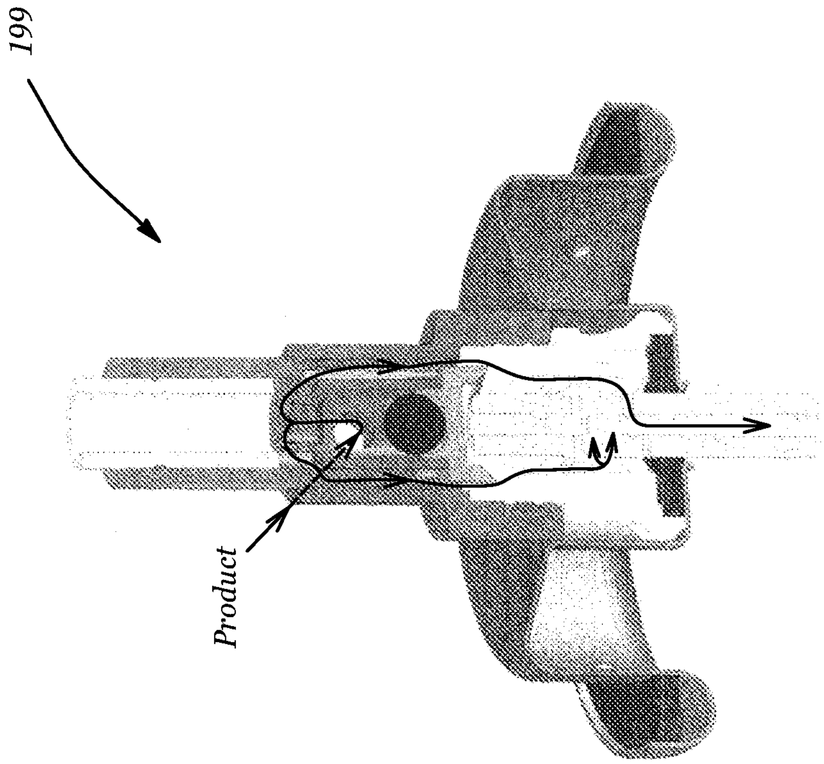


Figure 13

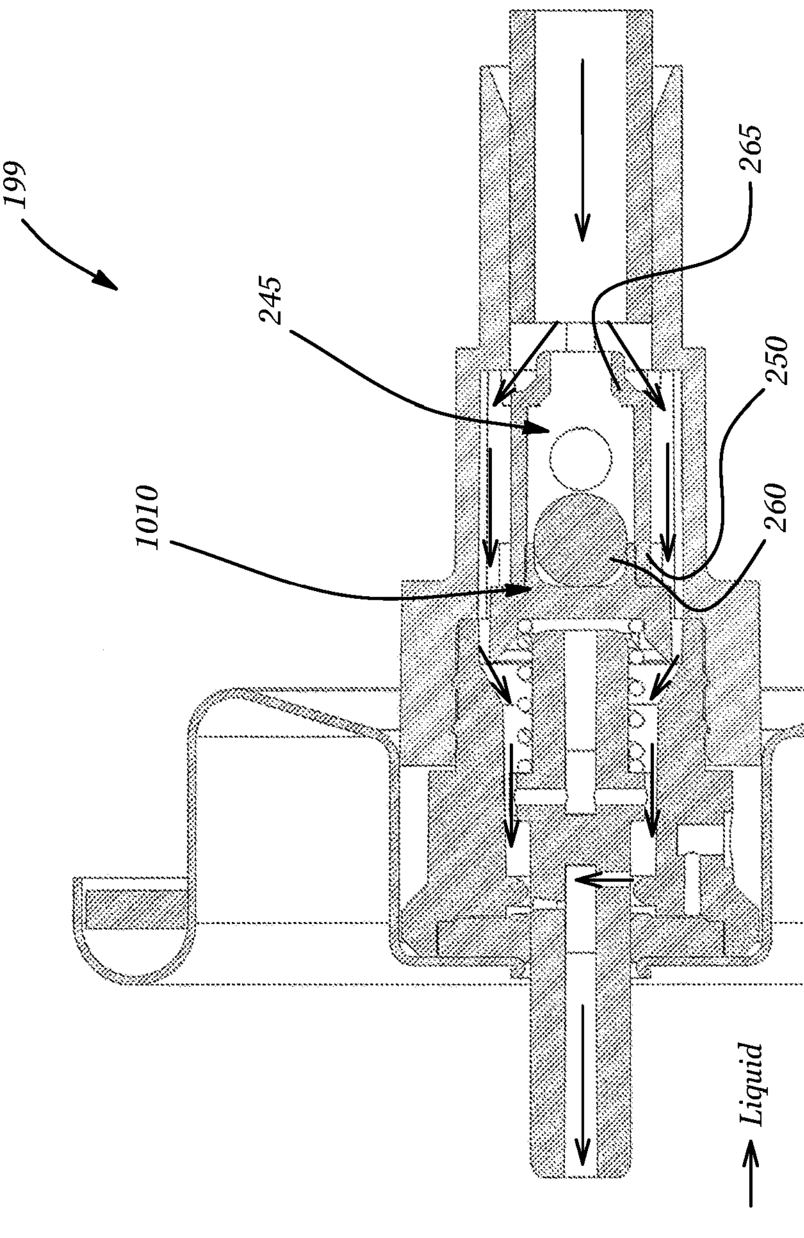


Figure 14a

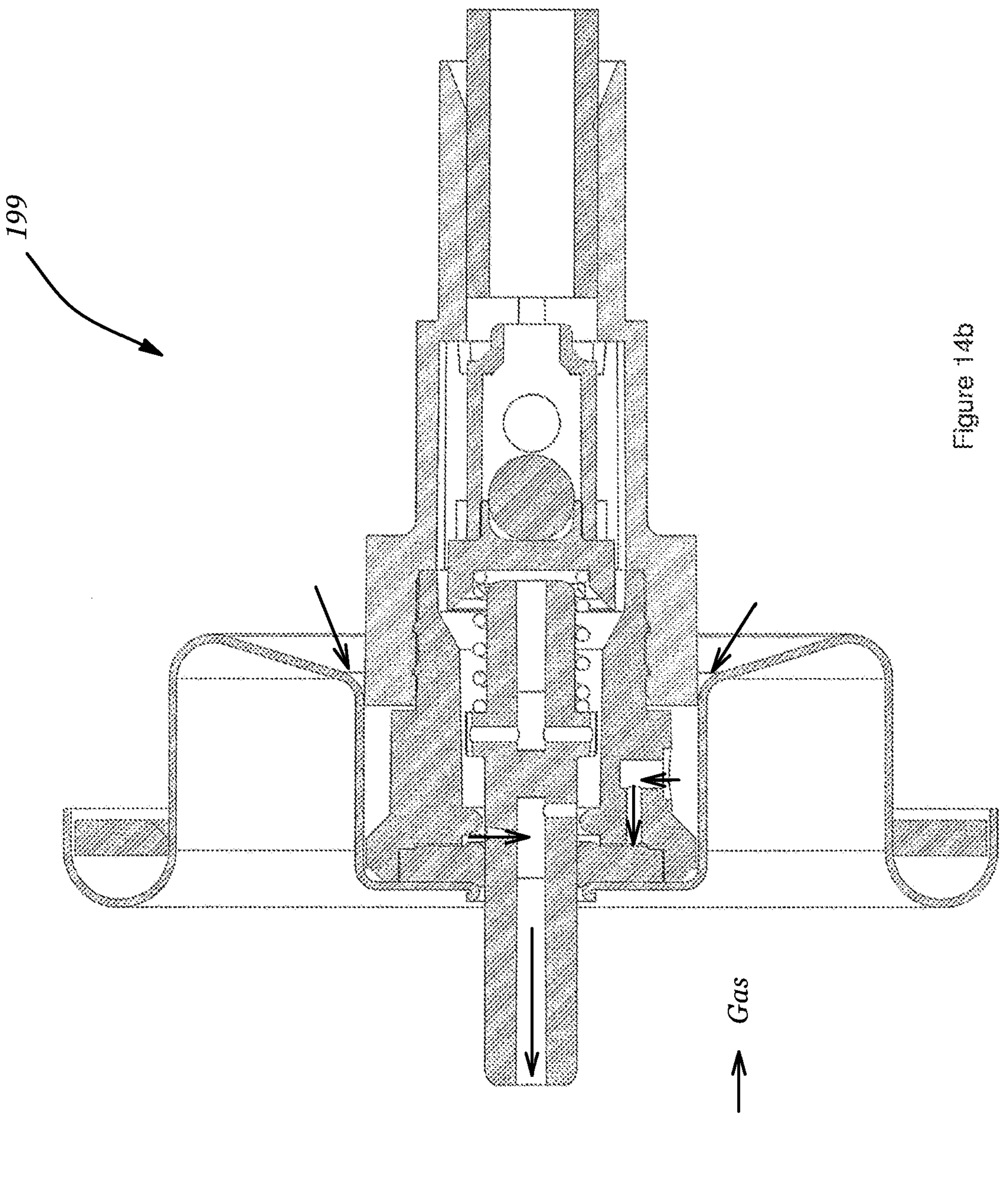


Figure 14b

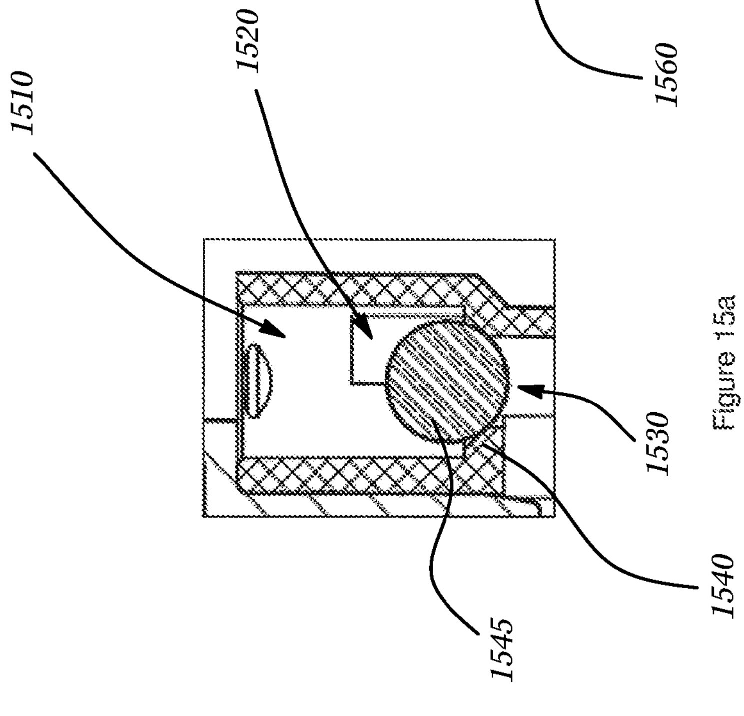


Figure 15a

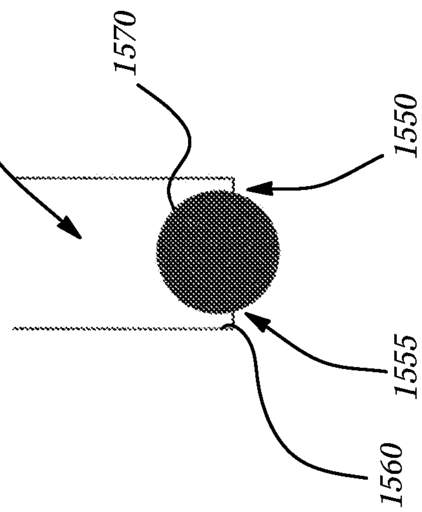


Figure 15b

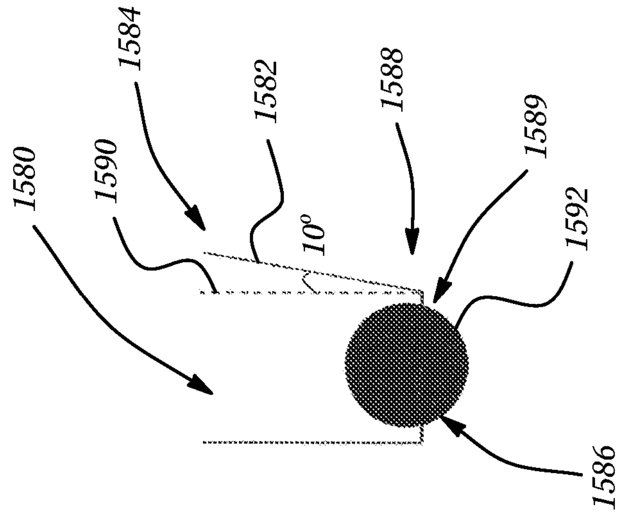


Figure 15c

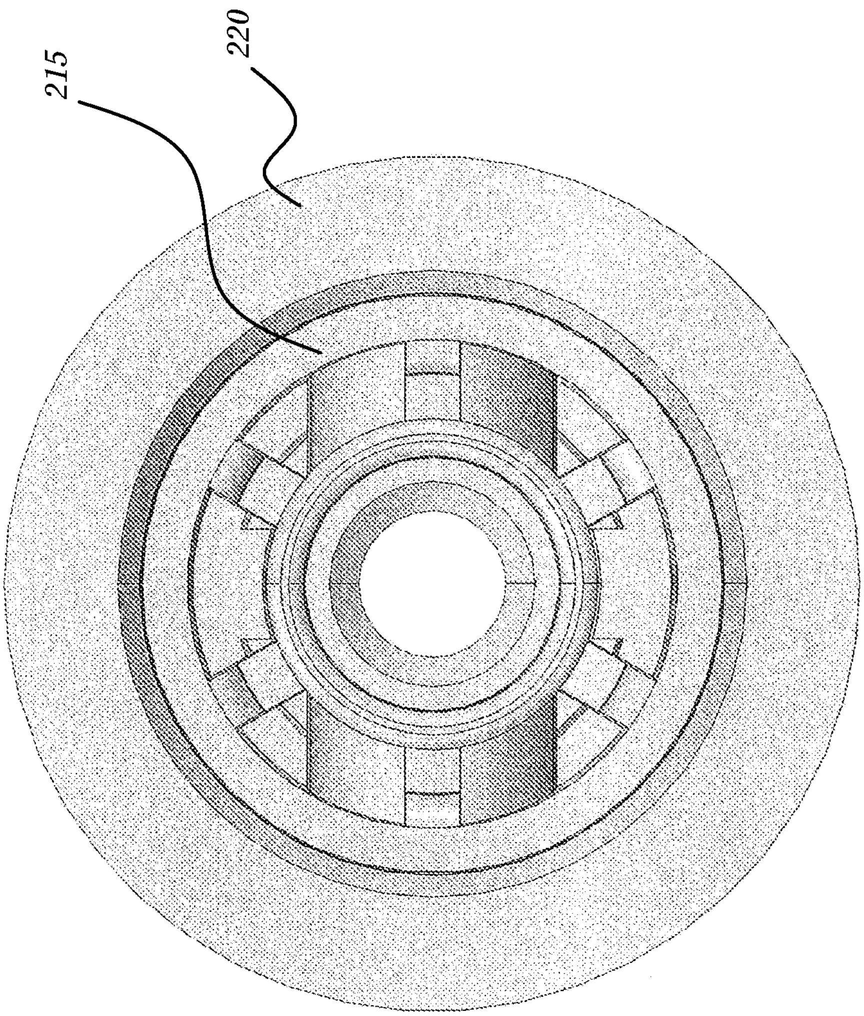


Figure 16

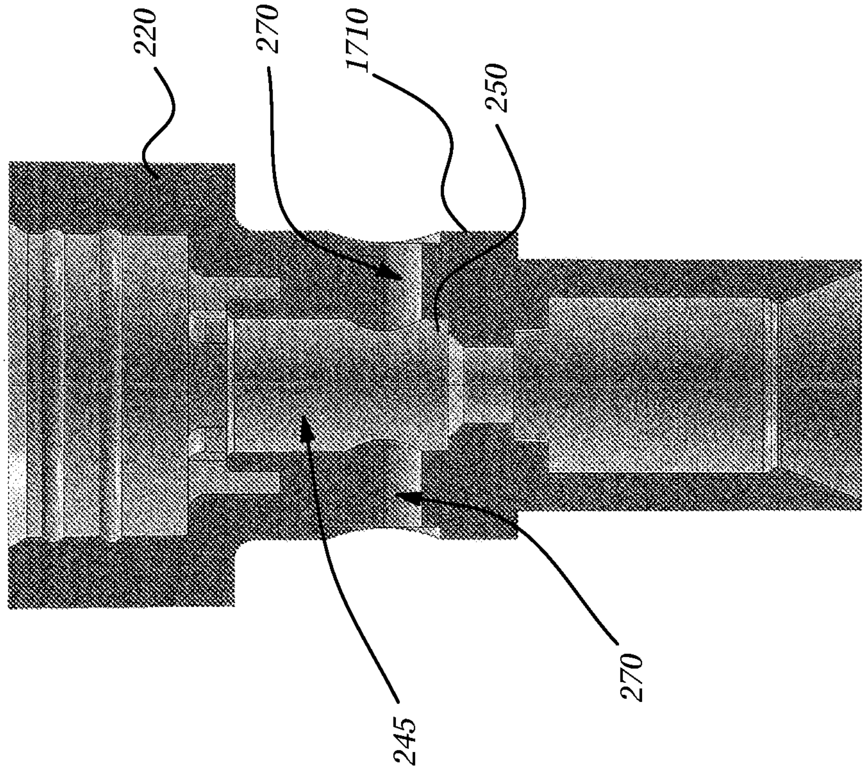


Figure 17

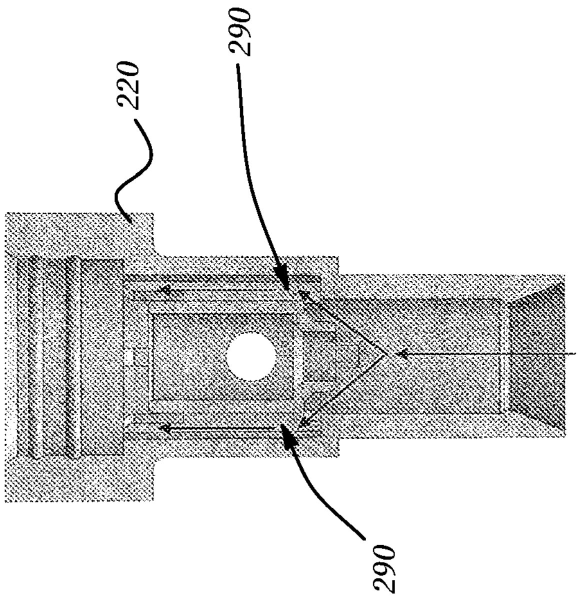


Figure 18

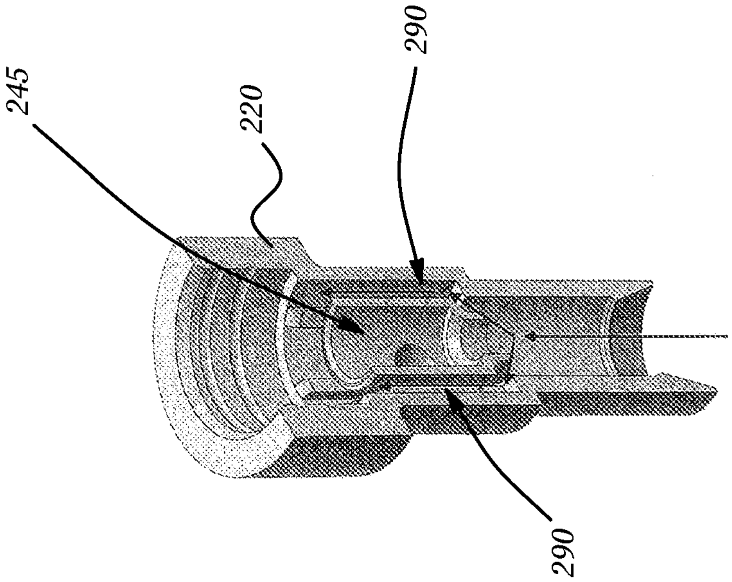


Figure 19

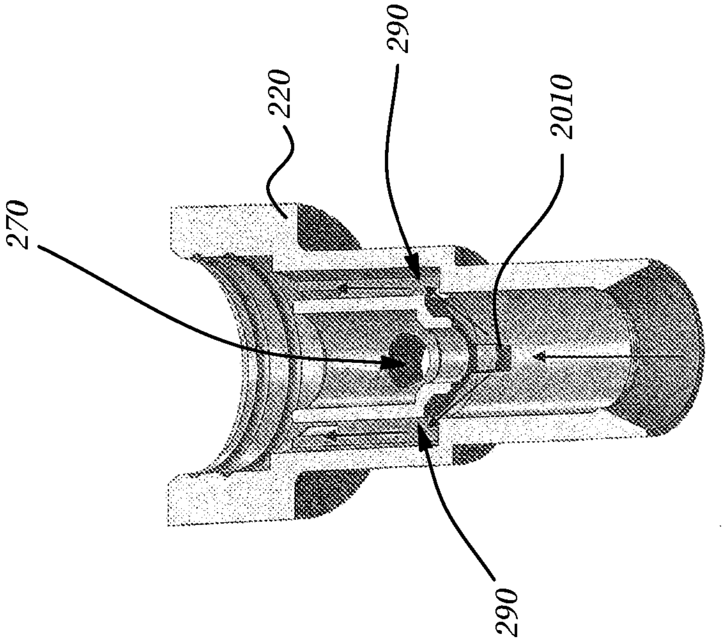


Figure 20

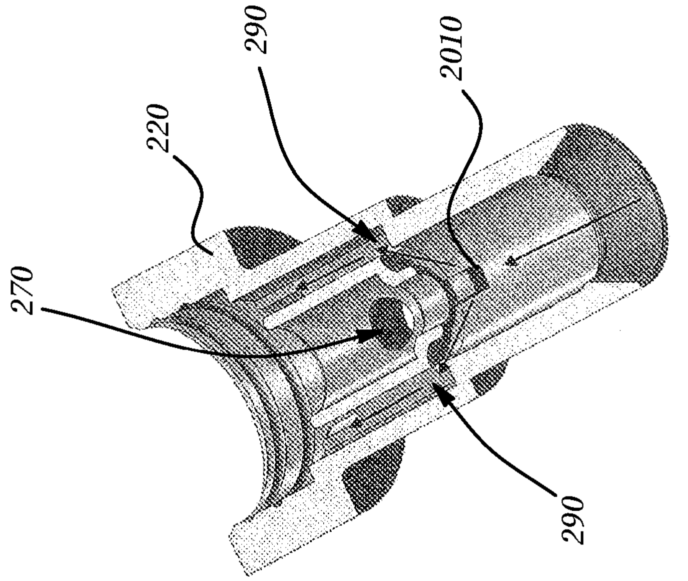


Figure 21

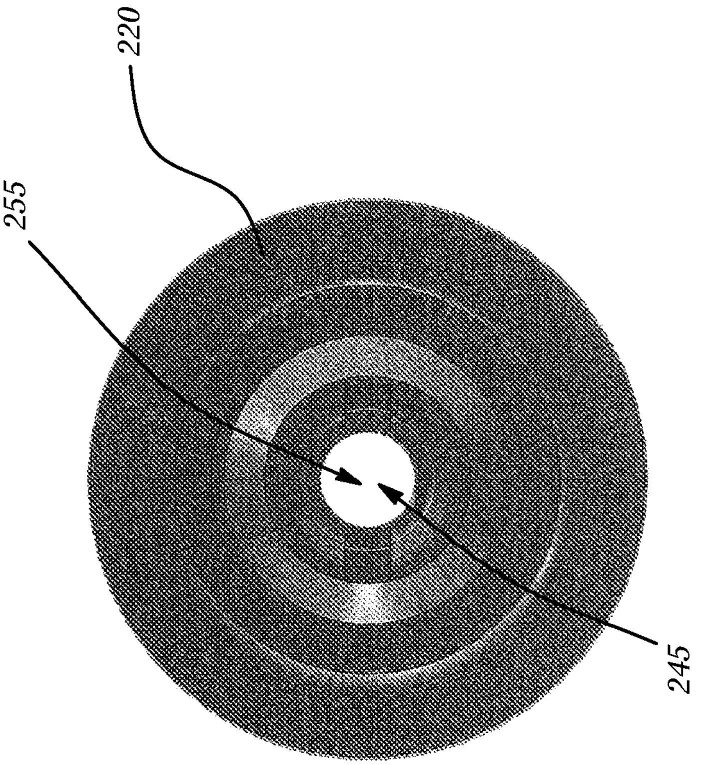


Figure 22

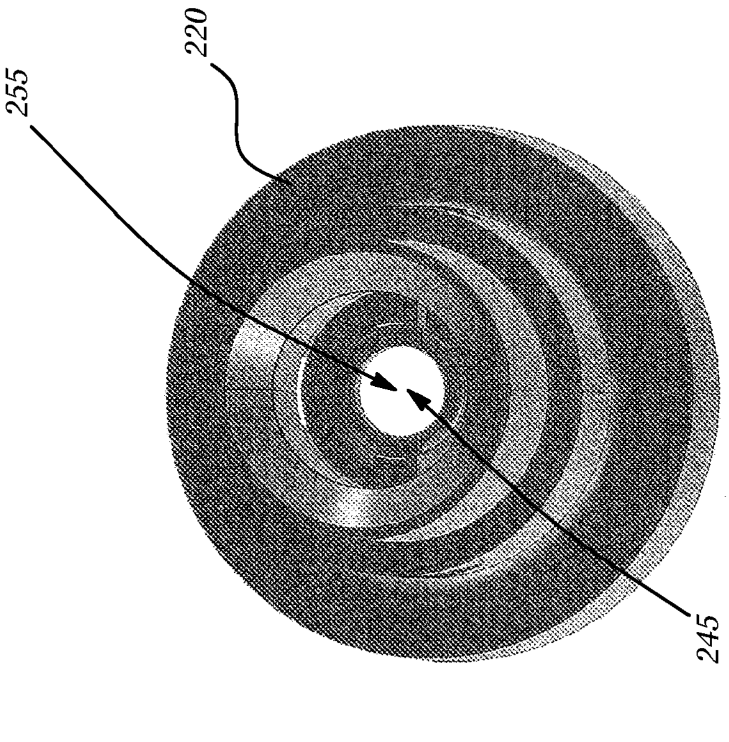


Figure 23

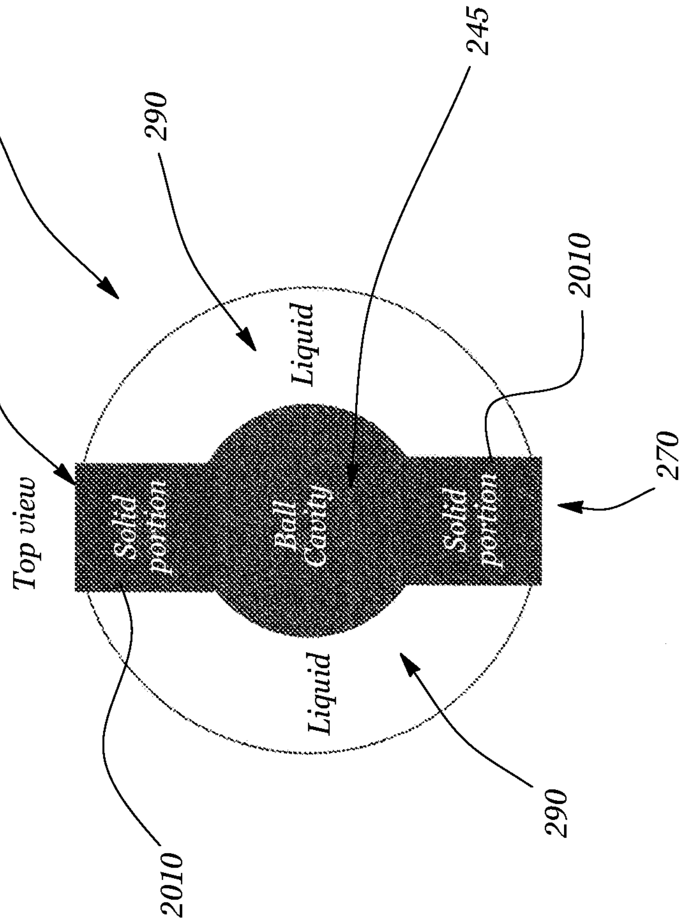

Top view
Solid portion
Ball Cavity
Solid portion
Liquid
Liquid
220
290
245
270
2010
270
2010
290

Figure 24

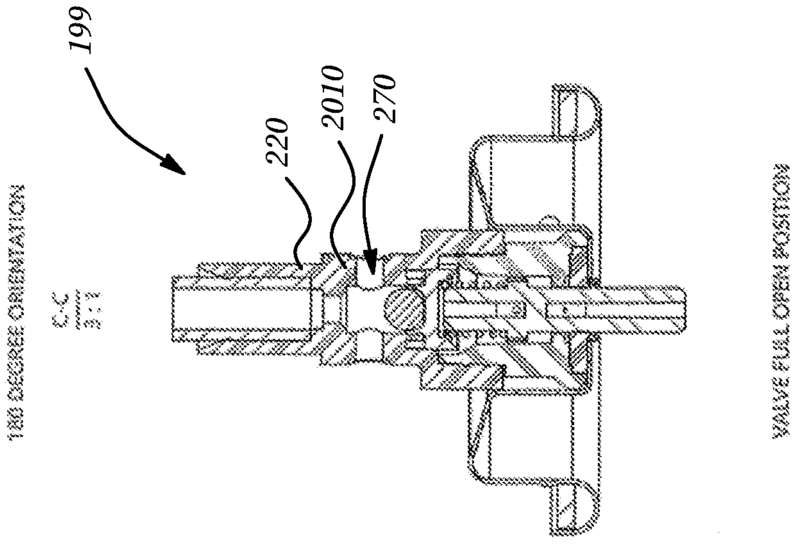


Figure 25c

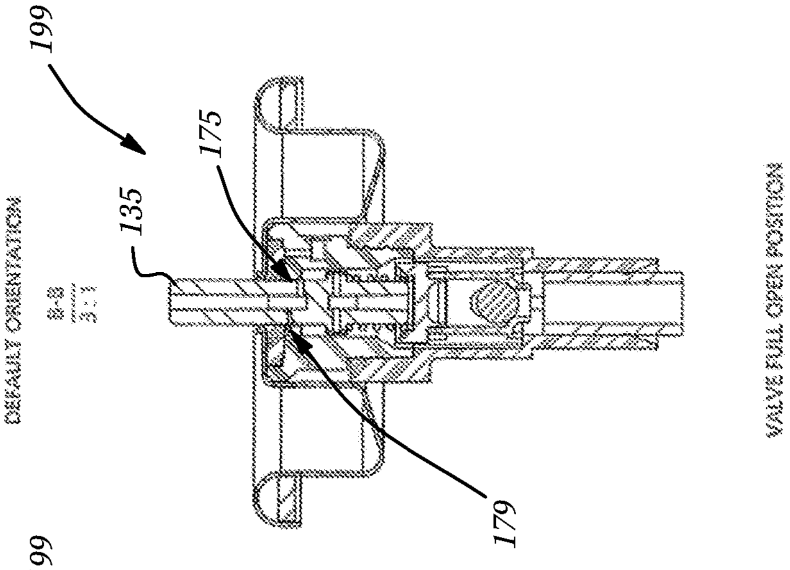


Figure 25b

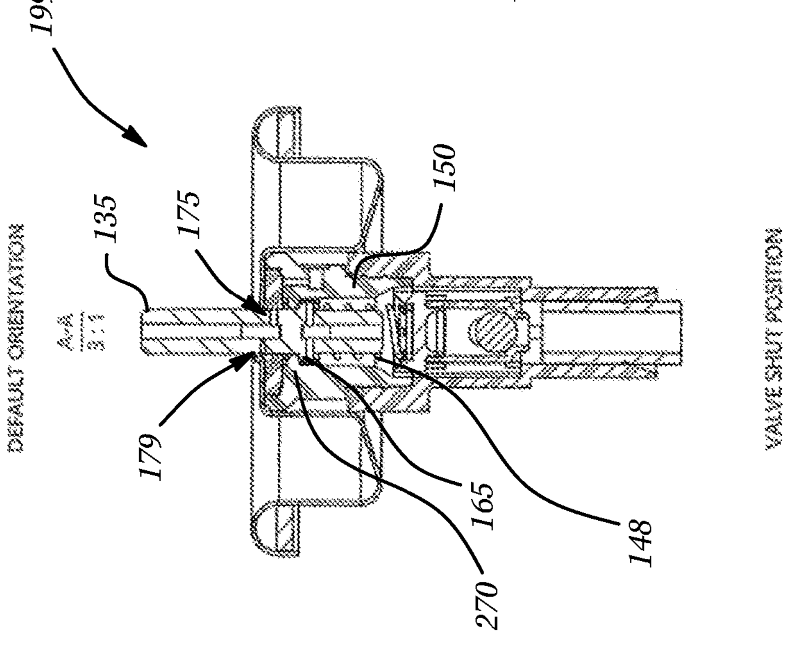


Figure 25a

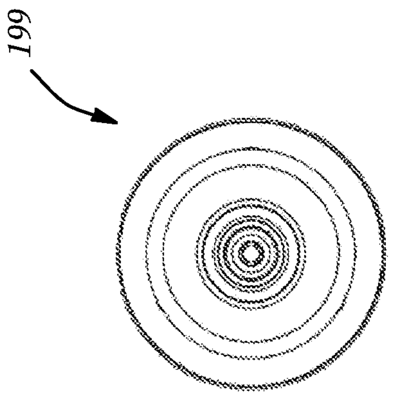


Figure 26b

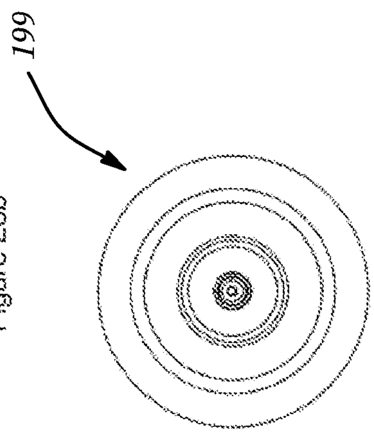


Figure 26c

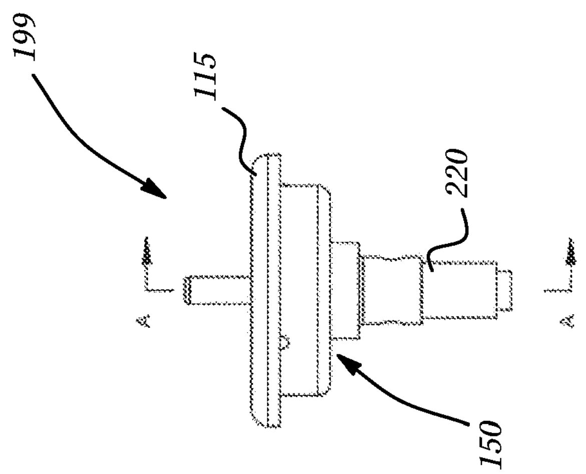


Figure 26a

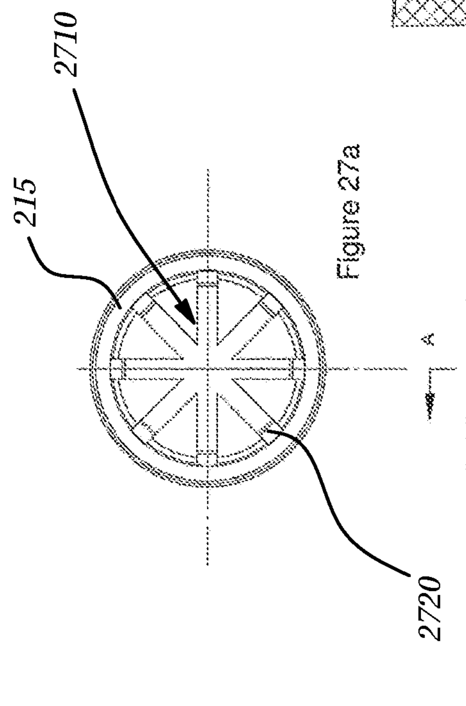


Figure 27a

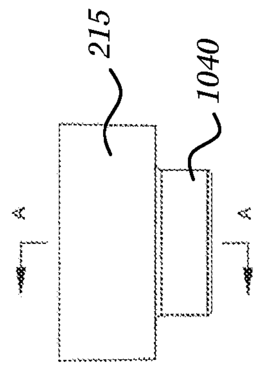


Figure 27b

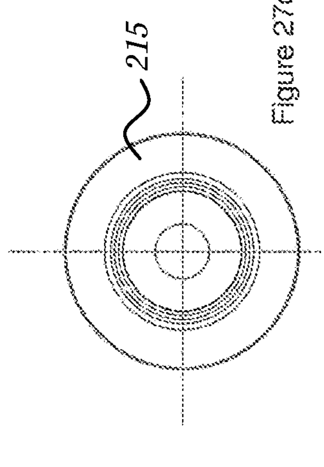


Figure 27c

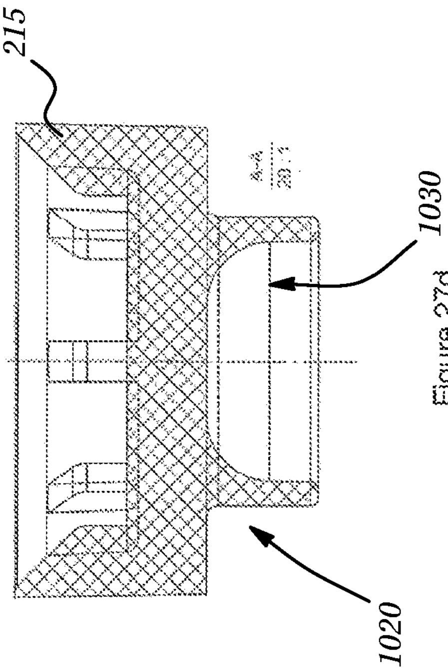


Figure 27d

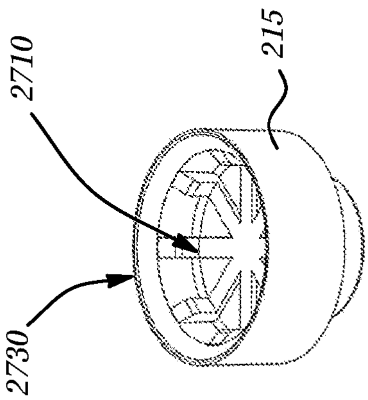
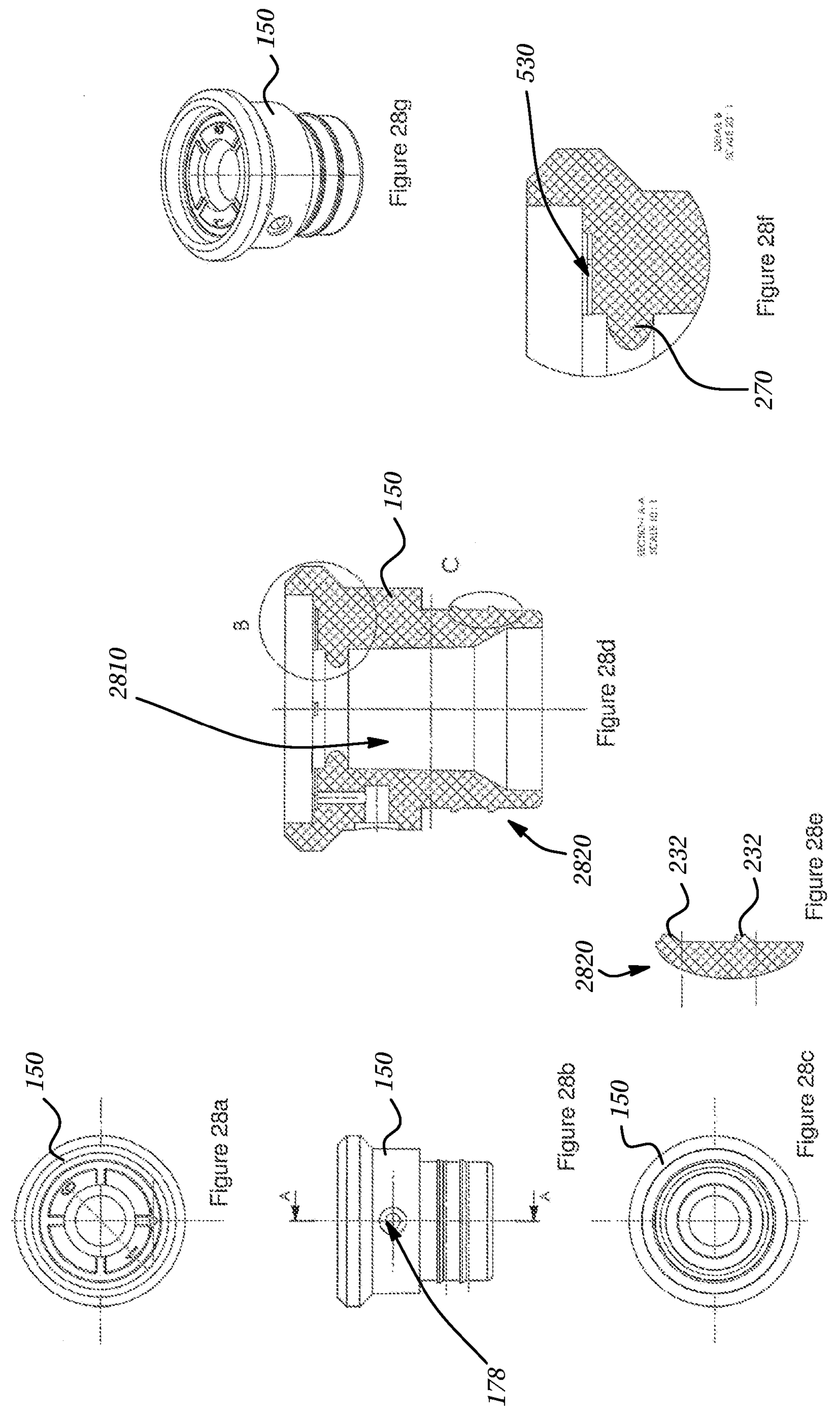


Figure 27e


150
Figure 28g
530
270
Figure 28f
2810
150
B
C
2820
Figure 28d
2820
232
232
Figure 28e
150
Figure 28a
150
A
A
178
Figure 28b
150
Figure 28c

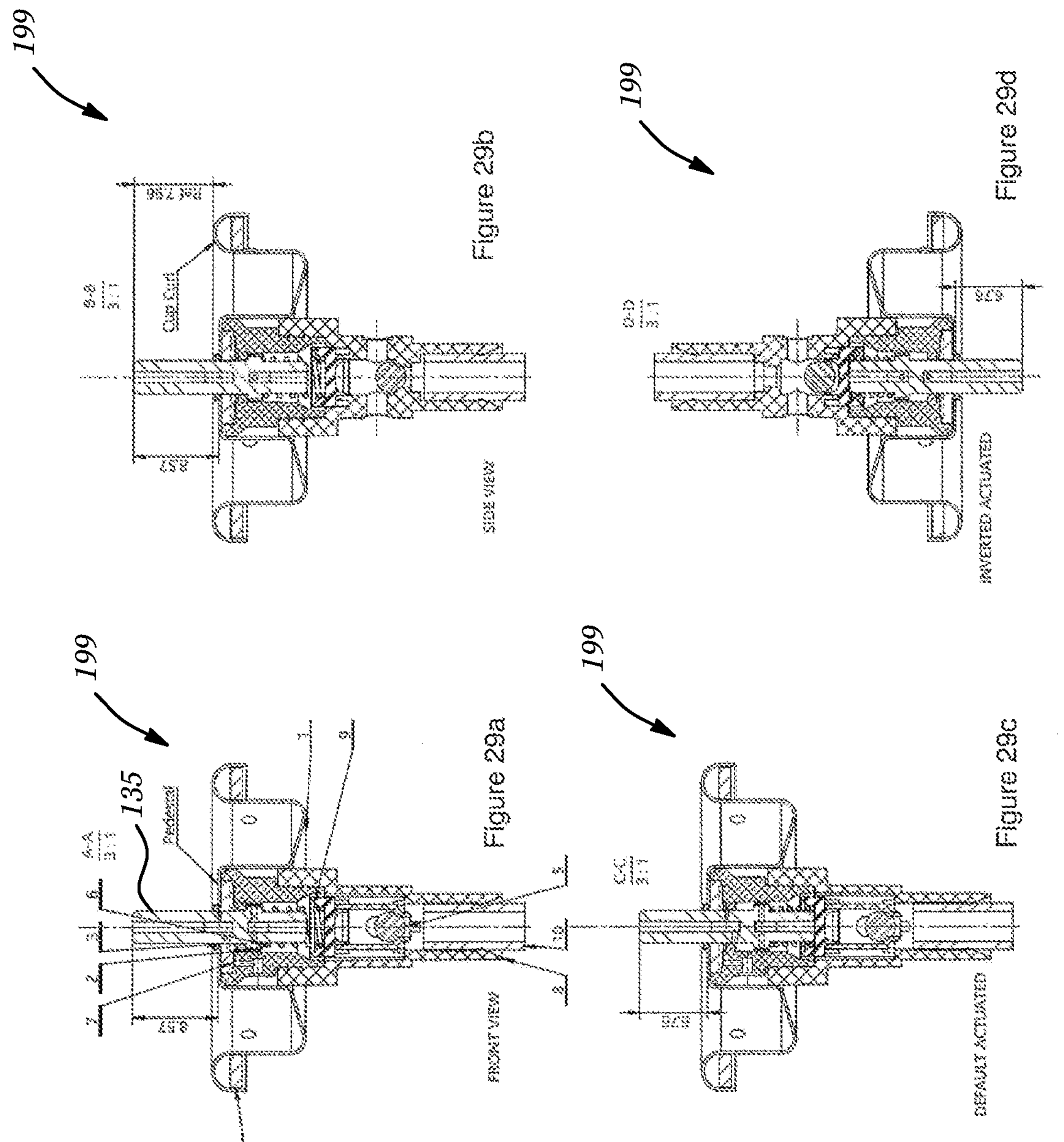


Figure 29a

Figure 29b

Figure 29c

Figure 29d

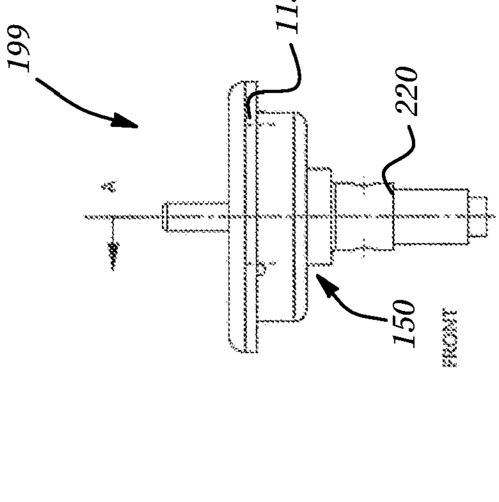


Figure 30a

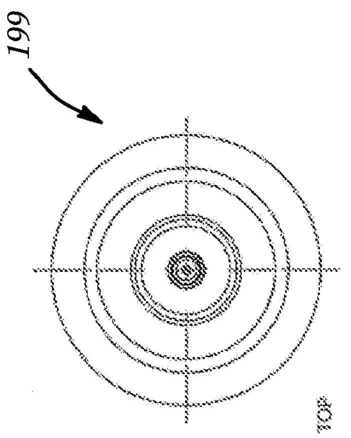


Figure 30b

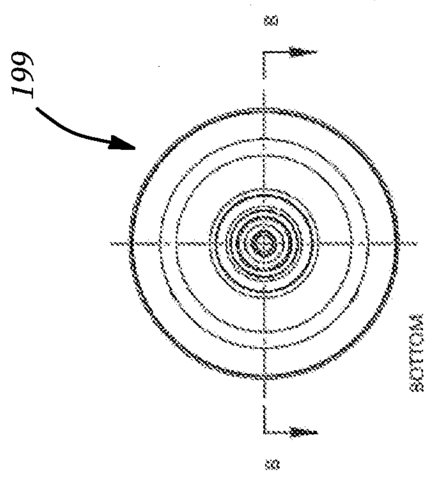


Figure 30c

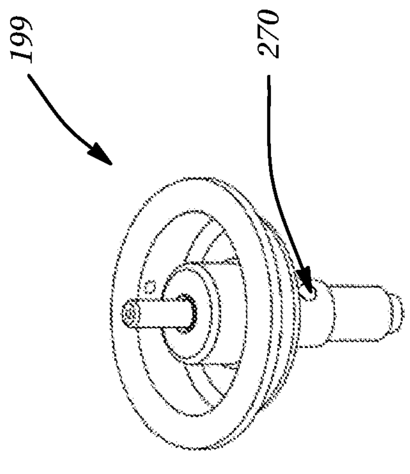


Figure 30d

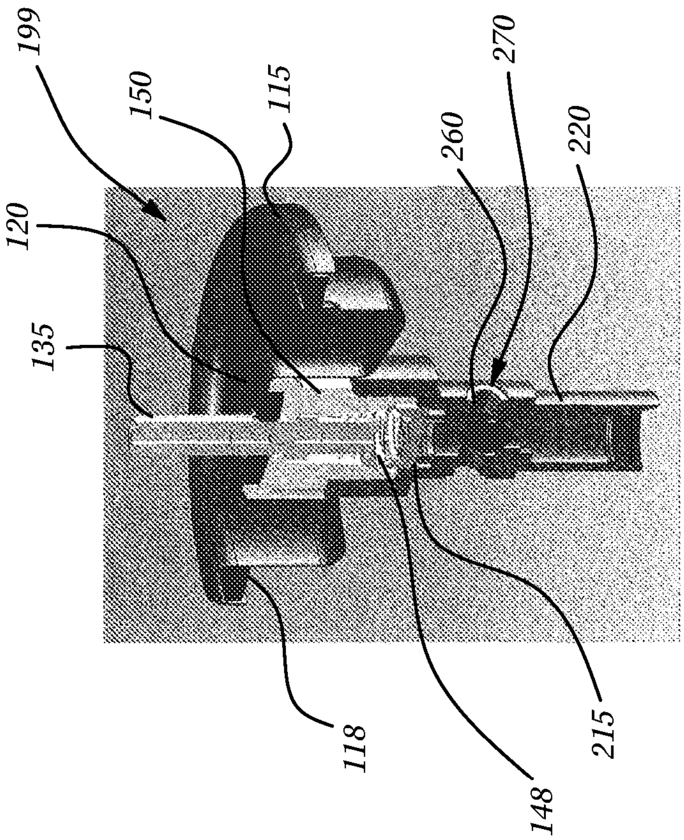


Figure 31b

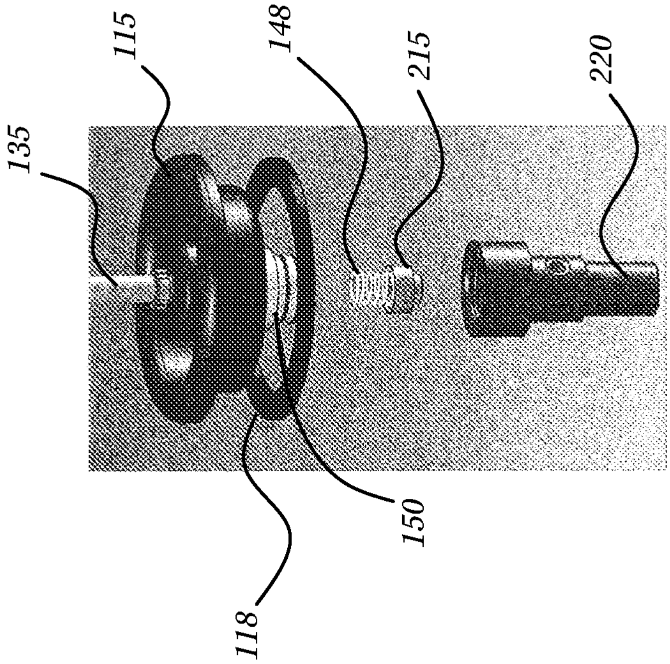


Figure 31a

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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